ENVIRONMENTAL PERFORMANCE REPORT AND MANAGEMENT PLAN FOR WATER ABSTRACTION BOREHOLES AT NAMIBIA BREWERIES LIMITED, WINDHOEK, KHOMAS REGION

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BASIS OF REPORT

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ACRONYMS AND ABBREVIATIONS

Acronym / Abbreviation	Definition
COW	City of Windhoek
DWAF	Department of Water Affairs and Forestry
EAPAN	Environmental Assessment Professionals of Namibia
ECC	Environmental Clearance Certificate
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
IMS	Imperial Managed Solutions
LDV	Light Diesel Vehicle
MAWF	Ministry of Agriculture, Water and Forestry
mbgl	meters below ground level
MAP	Mean Annual Precipitation
MET	Ministry of Environment and Tourism
SLR	SLR Environmental Consulting (Namibia) (Pty) Ltd
WNA	Windhoek North Aquifer
WNIA	Windhoek Northern Industrial Area

1 INTRODUCTION

1.1 BACKGROUND

The Namibia Breweries Limited (NBL) has been in operation since 1920, brewing beverages for local and international markets. The brewing plant is located at the corner of Dortmund and Iscor Street in the Northern Industrial Area of Windhoek, view Figure 1-1 for the location.

Prior to 2016, the brewery was supplied with water by the City of Windhoek (CoW) and Namibia Water Corporation Limited (NamWater) for the manufacture of its beverages. With the drought experienced in the Central Areas of Namibia (CAN) from 2015 and, which is still persisting, CoW was obligated to enforce water use restrictions on the users including households and industries such as NBL. Ultimately the brewery was led to explore alternative water sources to meet its daily water demand to perform efficiently. In total, the brewery needs a volume of 766 500 m^3/a.

Five (5) production boreholes (WW 204606, WW 204607, WW 204633, WW 204636 and WW 204637) were drilled in two phases between June 2015 and October 2016, targeting a deep seated fault zone in mica schist, underlying the shallow alluvial aquifer of the Windhoek North Aquifer. The boreholes intersected good yielding fractures at depths >50 m and were connected to the brewery water supply scheme. The brewery drilled an additional two (2) boreholes on its premises of which Borehole WW 204635 is a standby production borehole and WW 204634 is a monitoring borehole.

The groundwater has been chemically analysed and has been found to be of substandard quality due to elevated iron content, and therefore the water requires treatment through reverse osmosis prior to utilization.

A valid groundwater abstraction permit No. 11149 (Appendix 1) was issued by the Department of Water Affairs and Forestry (DWAF) on the 19th of October 2018, that permits NBL to abstract groundwater to the volume of 766 500 m^3/a from the above mentioned five (5) boreholes. Taking into consideration the permitted abstraction volume (766 500 m^3/a) a long term impact on the Windhoek North Aquifer (WNA) is expected because other industries have drilled boreholes into the same aquifer and are abstracting simultaneously. NBL appointed SLR Environmental Consulting (Namibia) (PTY) Ltd, (SLR) in 2016 to assess the impact of the projected abstraction level on the aquifer. SLR undertook an Aquifer Sustainability Assessment for the Windhoek North Aquifer (Appendix 3) that involved the following:

- The construction, calibration, validation and application for predictions of a steady state numerical groundwater model for the Windhoek North Aquifer using the MODFLOW-2005 code and the confidence level has been classified as ‘Class 1’ to ‘Class 2’ according to the Australian groundwater modelling guidelines. The model would support the abstraction permit application to the Department of Water Affairs and serve as a planning and aquifer management tool for NBL.

Due to the nature of groundwater abstraction activity and its industrial purposes, NBL requires compliance with the Environmental Management Act no.7 of 2007 and the Environmental Impact Assessment (EIA) Regulations and is subjected to an application for an Environmental Clearance

Certificate (ECC) through the Ministry of Environment and Tourism (MET). It is with this background that NBL has requested SLR to assist with the compliance process.

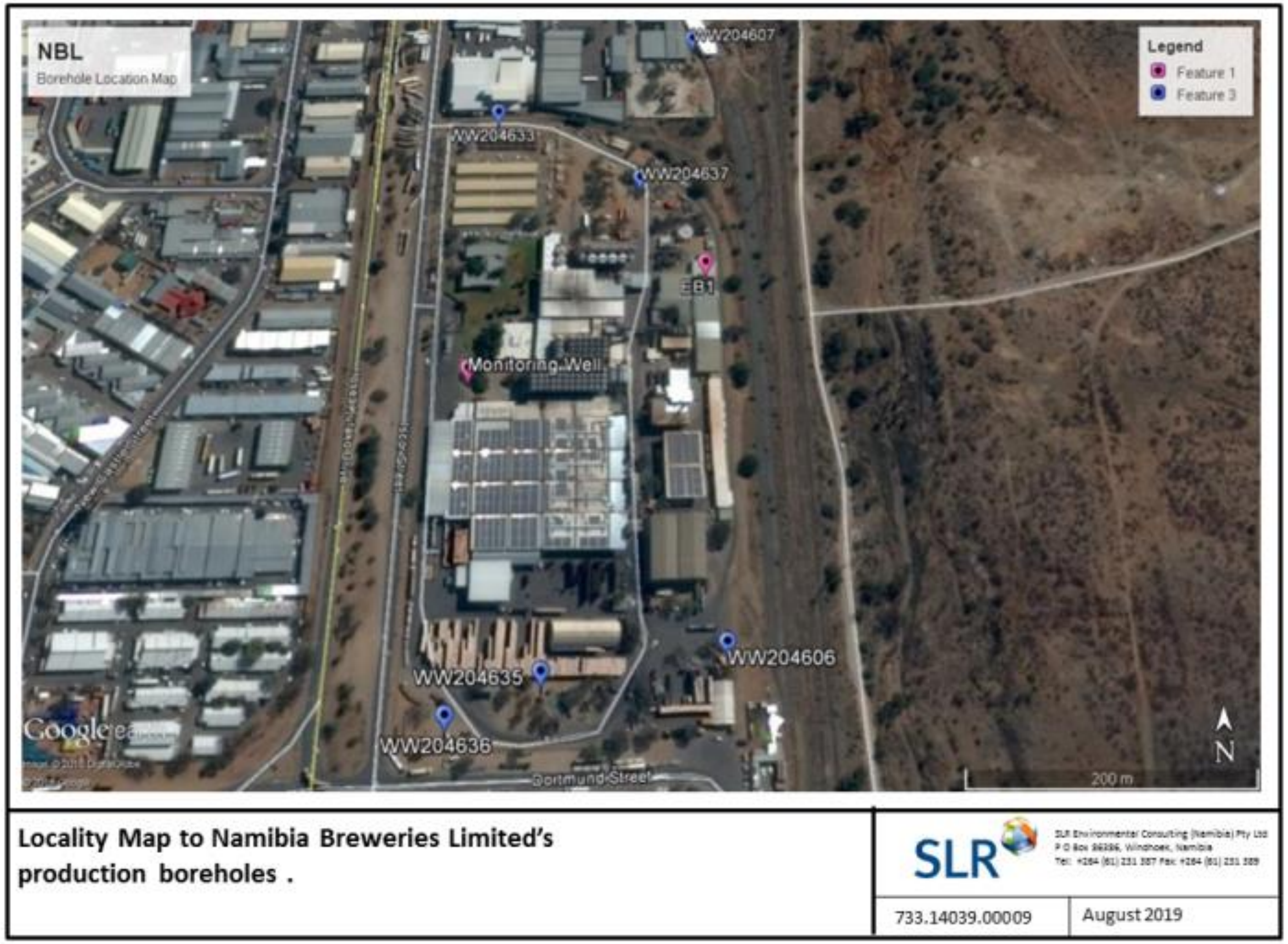

FIGURE 1-1: LOCALITY MAP TO NBL'S PRODUCTION AND MONITORING BOREHOLES (GOOGLE EARTH, 2019)

1.2 ENVIRO-LEGAL CONTEXT

In terms of the Environmental Management Act, 2007 (Act No. 7 of 2007) and associated Environmental Impact Assessment Regulations, water abstraction for industrial purposes is a listed activity which is regulated by the MET. The activity requires an Environmental Impact Assessment (EIA) process and an application for an Environmental Clearance Certificate (ECC). The listed activities refer to:

WATER RESOURCE DEVELOPMENTS

- Activity 8.1:The abstraction of ground- and surface water for industrial or commercial purposes;
- Activity 8.2: The abstraction of groundwater at a volume exceeding the threshold authorized in terms of law relating to water resources;

It is with this background that SLR prepared this report which provides the following;

- a description of current infrastructure and activities at NBL boreholes (WW 204606, WW 204607, WW 204633, WW 204636 and WW 204637) observed during a site visit on the 02 August 2019;
- details of the existing borehole monitoring programme;
- consideration of current environmental performance and risks; and
- mitigation measures associated with the groundwater abstraction activities within the permitted abstraction threshold of 766 500 m^3/a as detailed in the Aquifer Sustainability Assessment Report, which includes the monitoring and the maintenance of infrastructure.

This Environmental Performance Report and Management Plan (EMP) presents the current status of NBL's groundwater monitoring programme and documents a series of management plans (MPs) which are designed to meet legal requirements as well as avoid, minimise or mitigate the impacts associated with the abstraction of groundwater at the NBL premises. The EMP gives the commitments, which form the 'environmental contract' between NBL and the Government of the Republic of Namibia; represented by the Ministry of Environment and Tourism (MET).

1.3 DETAILS OF THE PERSONS WHO PREPARED THIS EMP

SLR Environmental Consulting (Namibia) (Pty) Ltd (SLR) is the independent Environmental Assessment Practitioner (EAP) who compiled this EMP.

Edward Perry is the Environmental Management Planning and Approvals Operations Manager for SLR in Africa. He has over 20 years environmental consultancy experience in Africa and Europe. Ed has a degree in Environmental Science and a Master's Degree in Freshwater Ecology and is a registered Environmental Auditor with the Institute of Environmental Management and Assessment in South Africa. Ed has undertaken EIAs, EMPs and Environmental Management Systems (EMS) for a wide range of organisations in the mining sector, food sector, metals processing sector, and public sector.

Ester Gustavo, the Project Manager and author holds a Master's Degree in Geology, has nine years' experience in groundwater and surface water assessment and has previously managed projects in the mining, power and energy industries.

Marvin Sanzila, the Project Assistant has seven years of experience in the environmental management discipline with four years' experience in the mining industry dealing with environmental management systems implementation (ISO14001), coordination, and implementation of EMPs, legal compliance and three years with EIAs. Marvin is a member of Environmental Assessment Professionals Association of Namibia (EAPAN) and currently serves on the EAPAN board.

2 BASELINE ENVIRONMENT

Information provided in this section is only relevant to the existing borehole locations/ setting and the water abstraction activity. The information in this chapter is acquired from SLR report for the Aquifer Sustainability Assessment (SLR, 2017-WG10) and additional baseline information is detailed in the (Appendix 3) of this report.

2.1 TOPOGRAPHY AND DRAINAGE

In general, the topography of the WNA is a shallow valley lying in a north to south orientation, with low ridges on the west and east bordering it. Ridges to the west are lower and less pronounced than those to the east. The Klein Windhoek River runs along the valley, draining to the north. The prominent Otjihavera mountain range to the east of the graben, and also the Khomas Hochland mountains in the west, lie further away from the study area (SLR, 2017-WG10).

2.2 CLIMATE

2.2.1 Rainfall

The average annual temperatures in Windhoek ranges between 18-20˚C. Frost can occur during winter.

Windhoek Meteorological Office rain-gauge data provides a rainfall record of more than 100 years length. The majority of rainfall (68 %) falls between January and March. The mean annual precipitation (MAP) for Windhoek is 376 mm, while the median is 270 mm. There have been eight years where the annual rainfall has been greater than 700 mm, with the highest annual rainfall of 1,003 mm recorded in 2011.

Aquifer recharge resulting from rainfall events is dependent on the temporal and spatial variation in precipitation as well as the host rock surface and subsurface susceptibility in terms of infiltration and storage. By virtue of its surface and subsurface hydrogeological conditions, the calcrete outcrops are potentially a good recharge area. Due to the fact that most of the precipitation in the region is in the form of thunderstorms, it is likely that some of the rain water infiltrates into open fractures and faults to finally reach the groundwater table before evaporating or flowing overland into the next drainage line (SLR, 2017-WG10).

2.3 GEOLOGY

The rocks of the Swakop Group underlie the WNA, which is located in the Southern Zone of the Damara Orogenic Belt, consisting of quartz-biotite schist, micaceous quartzite and amphibole schist of the Kuiseb Formation (refer to Figure 2-1 for local geological map of the WNA).

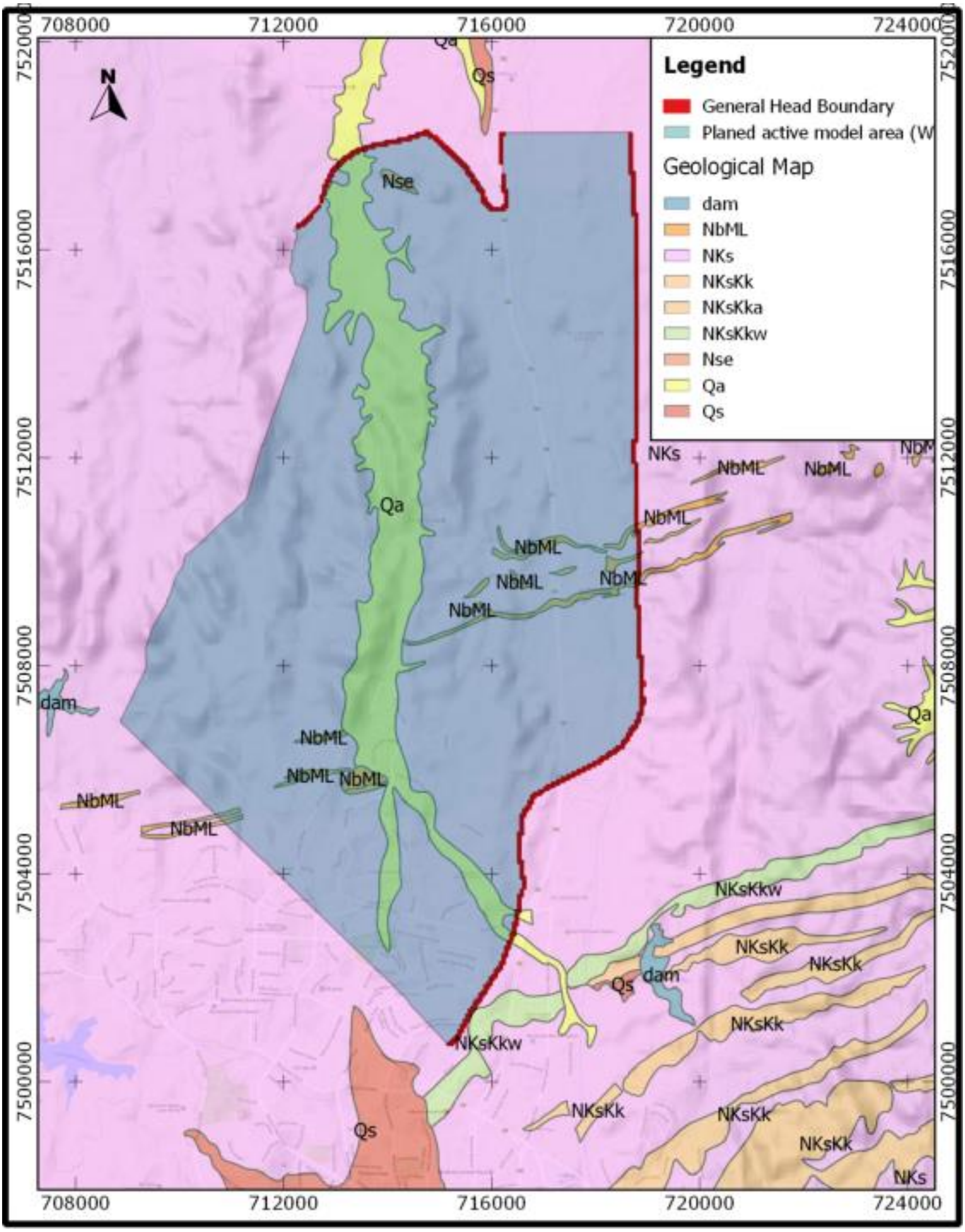

FIGURE 2-1: LOCAL GEOLOGY OF THE WNA (SLR, 2017-WG10)

The Southern Zone developed from an intra-continental rift into a narrow ocean, where the widespread greywacke succession of the Kuiseb Formation, now metamorphosed into schist, was deposited. The Windhoek Graben, which is part of a prominent fault system of Mid-Tertiary age developed as a result of extensional tectonics. Such extensional tectonics have occurred in the Earth's crust in southern Africa since the Early Cretaceous some 120 Ma ago, heralding the break-up of Gondwanaland. Activities on these faults are still, albeit to a minor extent, indicative of extensional tectonics continuing as the continents drift further apart. The graben forms the rough centre of the study area. The Windhoek Graben is about 70 km long and 20 km wide. To accommodate crustal stress, individual blocks were displaced vertically in relation to each other, along steeply dipping faults, with only minor horizontal movement.

2.4 HYDROGEOLOGY

Groundwater occurs in two different aquifer types in the Windhoek Graben underlying the WNA, i.e. (1) fractured meta-sedimentary rocks (mainly Kuiseb Schist) and (2) alluvial terraces covering the graben in the vicinity of the Klein Windhoek River.

The Kuiseb Schist Aquifer underlies the entire study area. Groundwater is thereby contained in tectonic features such as faults and fractures, which show a medium to high permeability, while the schistose rock matrix is largely impermeable.

The alluvial aquifer is known to be present mainly in the Brakwater area between the southern end of the WNA and farm Elisenheim. The water quality is mainly brackish and the shallow, porous aquifer is vulnerable to pollution from the Windhoek industrial area.

2.5 HYDROLOGY

The WNA is located in the catchment of the Swakop River, starting with the Klein Windhoek River, which rises in the Auas Mountains on the south eastern edge of Windhoek and flows in a generally northern direction through the eastern suburbs of Windhoek until it joins with the Aretaragas River, to become the Otjiseru River, which joins the Swakop River west of Okahandja approximately half way between Okahandja and the Swakoppoort Dam. The Avis Dam is located just upstream of the study area in the Klein Windhoek River.

2.6 AQUIFER SYSTEM

Groundwater within the project is hosted in two distinct aquifer types, in an alluvial aquifer and in fractured bedrock aquifers. The alluvial aquifer, represented by the Klein Windhoek River and alluvium associated with the valley floor, holds water in intergranular pore spaces, whereas water in the fractured bedrock aquifers is held in fissures and fractures in otherwise impermeable strata. Figure 2-2and Figure 2-3 show the schematic cross- and long sections of the project area, cutting through the NBL premises.

It is assumed that there is only a limited hydraulic connection between the alluvial aquifer and the bedrock aquifers, i.e. perched aquifer conditions dominate within the alluvial aquifer and hydraulic connection to the bedrock aquifer with major groundwater exchange only taking place in areas where faults striking the river system act as water conduits.

Water levels recorded during the hydrocensus campaign carried out in January 2017 are shown in Figure 2-4 for the respective boreholes. These groundwater levels were used to generate a groundwater level contour map, Figure 2-5

The contour map in Figure 2-5 was produced by linear interpolation of groundwater heads, derived by subtracting water level data recorded during the hydrocensus and data found in GROWAS, from SRTM data for the study area. It indicates a steep groundwater head gradient from east to west with the steepest gradient along the hills to the east as they flatten out into the valley. The gradient from south to north is much flatter and becomes less pronounced to the west.

The regional groundwater flow is directed southeast-northwest across the fracture zones in the schist with a less pronounced flow from south to north in the alluvial aquifer.

The Matchless member forms a southwest-northeast striking flow barrier of which the continuity is not clear and the extent of flow retardation caused will need to be quantified in future. It is assumed to be the southern boundary of the WNA.

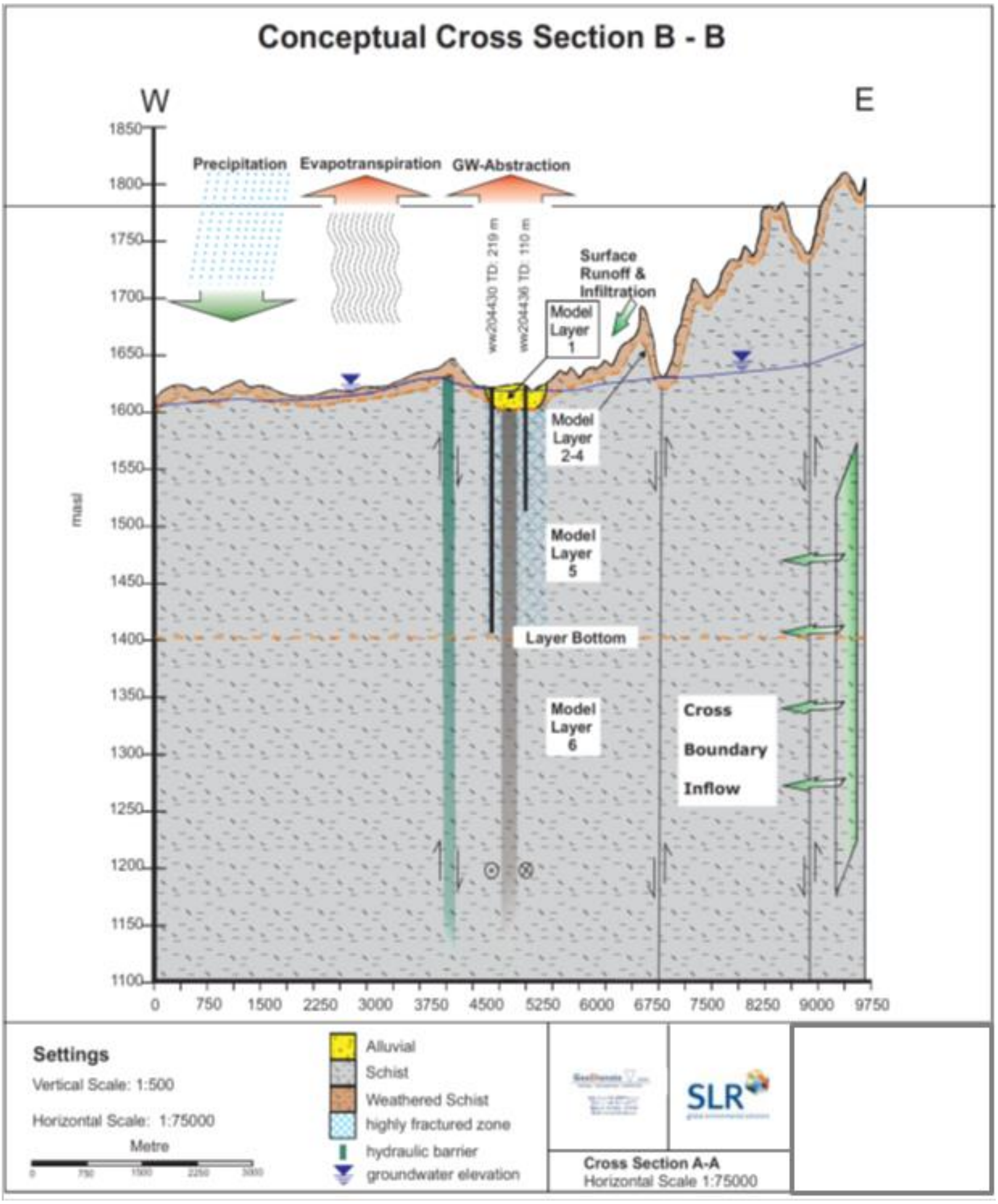

FIGURE 2-2 SCHEMATIC CROSS-SECTION RUNNING EAST-WEST ACROSS THE STUDY AREA (SLR, 2018)

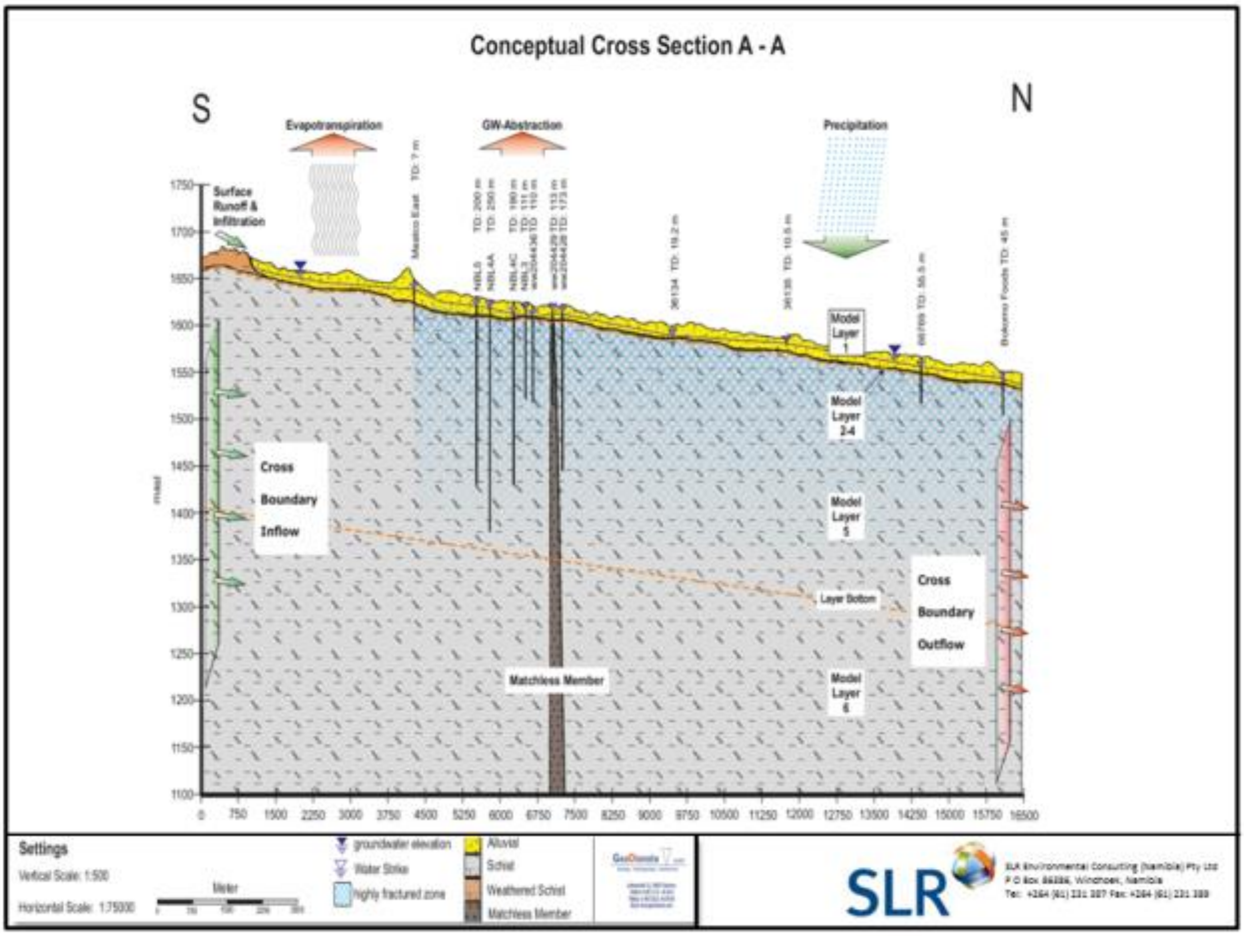

FIGURE 2-3: SCHEMATIC LONG SECTION RUNNING NORTH-SOUTH ALONG THE STUDY AREA (GEODIENSTE, 2017)

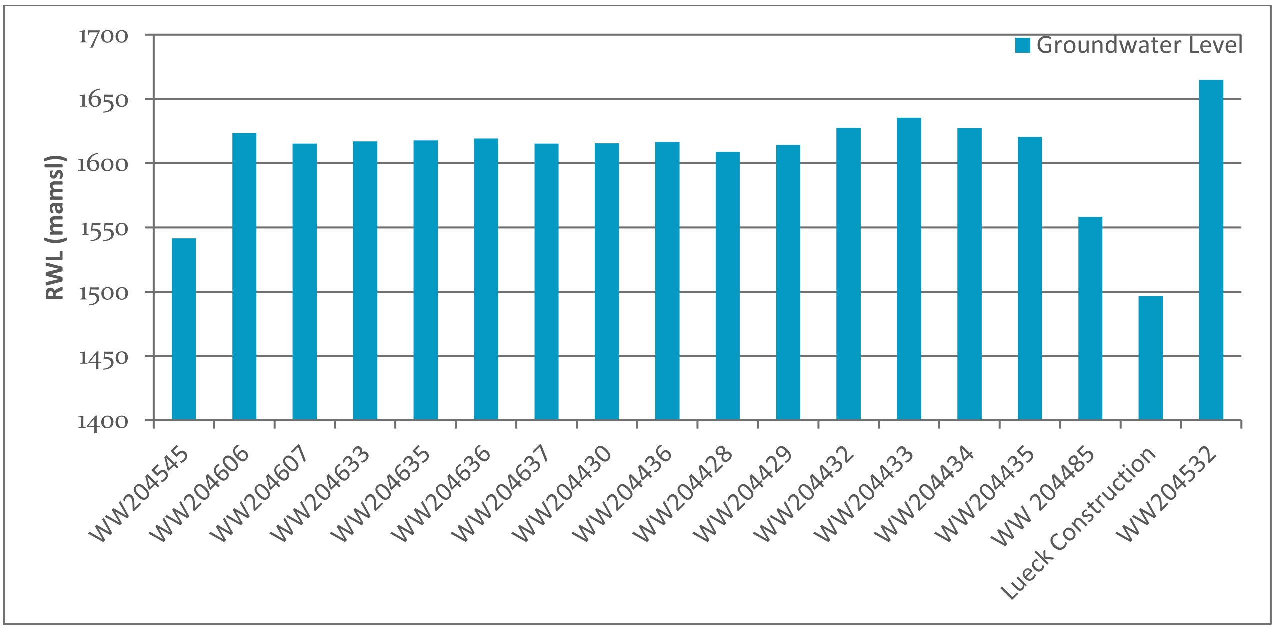

FIGURE 2-4: WNA WATER LEVEL ELEVATION, 2017 (BOREHOLES USED IN THE MODEL)

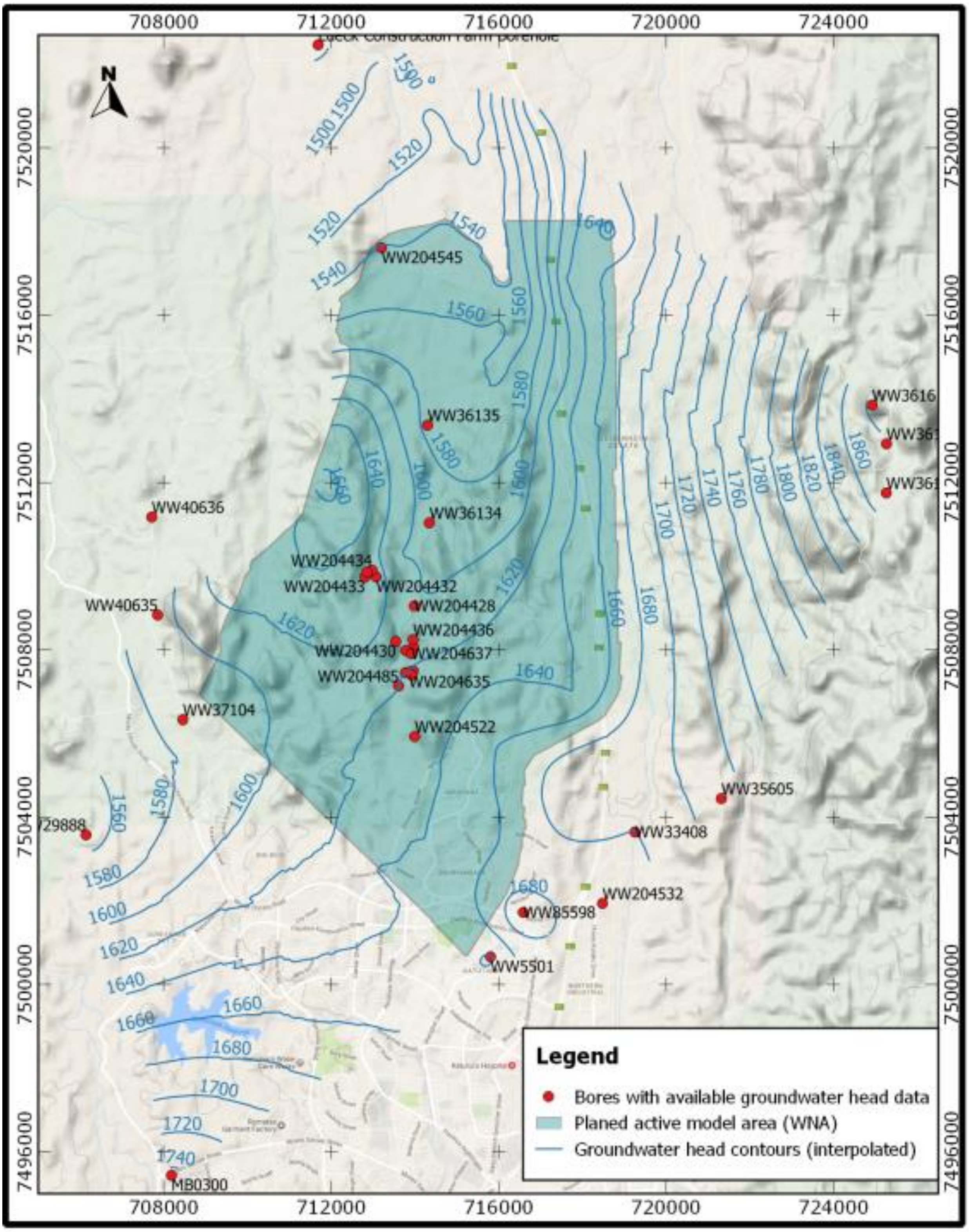

FIGURE 2-5: LOCATION OF BOREHOLES WITH GROUNDWATER CONTOURS (GEODIENSTE, 2017)

3 LOCATION OF BOREHOLES AND INFRASTRUCTURE

Information provided in this section has been summarised from Appendix 2, which includes photographs taken of the visited borehole sites.

3.1 DESCRIPTION OF BOREHOLE'S LOCATION AND EXISTING INFRASTRUCTURE

3.1.1 Brewery infrastructure

The abstraction boreholes are on industrial/commercial land with existing associated infrastructure. To support the brewing activities, the plant includes the following: Refer to Figure 1-1 for locality map to the Boreholes and Brewery infrastructure.

- an administrative center with offices;
- a water treatment plant;
- storage yard, biomass fuel facility;
- car parking area;
- cafeteria;
- logistic centre;
- truck port;
- boreholes;
- sewer and effluent discharge systems;
- bottling facility;
- biomass plant/ boiler; and
- scrap yard
- Heavy Fuel Oil storage (HFO)
- Brewing facilities (fermentation tanks and hops and malt storage tanks)

3.1.2 Borehole WW204606

Borehole WW204606 is a production borehole located within the fenced perimeter on the south-eastern side of the brewery premises, where the train enters the premises. Access to the borehole is restricted in that it is has a lockable metal container built around it and the keys are held by the Engineer. An electric abstraction pump is installed for this borehole with the main switch securely locked within the container. The borehole is installed with a telemetry SCADA monitoring system that is remotely controlled from a control room. The SCADA system accurately monitors the groundwater levels and pumping rates. The system therefore avoids commuting back and forth to the borehole site and eliminates opportunities for vandalism and wear and tear of equipment. (Refer to Appendix 2 for additional borehole site description).

3.1.3 Borehole WW204637

Borehole WW204637 is a production borehole located within the fenced perimeter on the north-eastern side of the brewery premises, by the scrapyard. Access to the borehole is restricted in that it is has a lockable metal container built around it and the keys are held by the Engineer. An electric abstraction pump is installed for this borehole with the main switch securely locked within the container. The borehole is installed with a telemetry SCADA monitoring system that is remotely controlled from a control room. The SCADA system accurately monitors the groundwater levels, pumping rates. The system therefore avoids commuting back and forth to the borehole site and eliminates opportunities for vandalism and wear and tear of equipment. The container is surrounded by storage material (Refer to Appendix 2 for additional borehole site description).

3.1.4 Borehole WW204633

Borehole WW204633 is a production borehole located within the fenced perimeter on the northern side of the brewery premises, along the main truck entrance and access road. Access to the borehole is restricted in that it is has a lockable metal container built around it and the keys are held by the Engineer. An electric abstraction pump is installed for this borehole with the main switch securely locked within the container. The borehole is installed with a telemetry SCADA monitoring system that is remotely controlled from a control room. The SCADA system accurately monitors the groundwater levels, pumping rates. The system therefore avoids commuting back and forth to the borehole site and eliminates opportunities for vandalism and wear and tear of equipment. (Refer to Appendix 2 for additional borehole site description).

3.1.5 Borehole WW204634

Borehole WW204634 is a monitoring borehole, drilled only into the alluvium. The borehole is located within the fenced perimeter on the western side of the brewery premises, between the logistics port and the cafeteria. Access to the borehole is currently un- restricted in that while it has a lock it has not been locked and it remains open to vandalism. It has been installed with a sensor-logger to continuously measure the water level. The data recorded on the logger is downloaded from the logger once a month. (Refer to Appendix 2 for additional borehole site description).

3.1.6 Borehole WW204636

Borehole WW204636 is a production borehole located within the fenced perimeter on the southern side of the brewery premises, on the side of the Namib Mills plant. Access to the borehole is restricted in that it is has a lockable metal container built around it and the keys are held by the Engineer. An electric abstraction pump is installed for this borehole with the main switch securely locked within the container. The borehole is installed with a telemetry SCADA monitoring system that is remotely controlled from a control room. The SCADA system accurately monitors the groundwater levels, pumping rates. The system therefore avoids commuting back and forth to the borehole site and eliminates opportunities for vandalism and wear and tear of equipment. (Refer to Appendix 2 for additional borehole site description).

3.1.7 Borehole WW204635

Borehole WW204635 is a production borehole located within the fenced perimeter on the southern side of the brewery premises, on the side of the Namib Mills plant, behind the bottle storage facility. The access to the borehole is partially restricted compared to the other production boreholes. Although the borehole does not have a lockable metal container built around it, it is welded close with no means to open the metal casing without a grinder. The borehole is a standby production borehole. It is therefore not installed with an electric abstraction pump nor any sensors linked to the SCADA system. (Refer to Appendix 2 for additional borehole site description).

3.1.8 Borehole WW204607

Borehole WW204607 is a production borehole located within the fenced perimeter on the south-eastern side of the Cashbuild building, which is located north and outside the main brewery premises. Access to the borehole is restricted in that it is has a lockable metal container built around it and the keys are held by the Engineer. An electric abstraction pump is installed for this borehole with the main switch securely locked within the container. The borehole is installed with a telemetry SCADA monitoring system that is remotely controlled from a control room. The SCADA system accurately monitors the groundwater levels, pumping rates. The system therefore avoids commuting back and forth to the borehole site and eliminates opportunities for vandalism and wear and tear of equipment. (Refer to Appendix 2 for additional borehole site description).

4 WATER MONITORING METHODS

4.1 Groundwater Abstraction

The extent to which NBL's abstraction of groundwater is internally regulated is based on the results from the SLR's Aquifer Sustainability Assessment Report of the Windhoek North Aquifer undertaken in July 2018 (Appendix 3). This indicated that abstraction rates of up to 2100 m^3/day (normal production months at 7 days per week) were sustainable. NBL undertakes regular monitoring of groundwater abstraction with the automated SCADA system to ensure that permitted annual groundwater abstracted volumes of 766 500m^3/annum are not exceed.

Reference is made to conditions of the groundwater abstraction Permit Number 11149 (Appendix 1)

The recommended maximum and sustainable abstraction rate for all the boreholes are shown in Table 4-1. The abstraction rate is based on a 20hour/7day only pumping cycle to allow the boreholes to recover and to allow the measurement of rest water levels when the pump is switched off. NBL has not reached this pumping volume since the permit was granted and abstraction volumes have always been below 800m^3/d (refer to Figure 4-1). This abstraction rate is expected to increase up to the 2100m^3/d once the reverse osmosis plant is in full operation.

TABLE 4-1: CURRENT WATER SUPPLY AND MONITORING BOREHOLES (SLR 2018)

Boreholes	Recommended abstraction rate		Pump Inlet Depth	Pump Water Level
	(m^3/h)	(m^3/day)	(mbgl)	(mbgl)
WW204606	15	300	55	15
WW204607	25	500	70	20
WW204636	25	500	70	15
WW204633	15	300	70	18
WW204637	25	500	70	20
WW204635	Standby production borehole			
WW204634	Monitoring borehole of the shallow alluvial aquifer			
Total	**105**	**2100**		

4.2 Water Quality Analysis

Groundwater quality monitoring for NBL is not currently undertaken annually. Different water sources including city water and borehole water have been sampled and analysed. Borehole water was analysed by Analytical Laboratory Services (ALS) in Windhoek, in 2016, See Table 4-3. The city water was analysed by Quality Assurance Laboratories in the Netherlands in 2019. The results are given in APPENDIX 4.
ALS uses the Namibian Drinking Water Guidelines and identifies the water quality based on the Group in Table 4-2 below, whereby:

- Group A = Water with an excellent quality
- Group B = Water with an acceptable quality
- Group C = Water with a low health risk
- Group D = Water with a high health risk or unsuitable for human consumption

TABLE 4-2: NAMIBIAN DRINKING WATER GUIDELINE OF 1991

Water Parameters	Namibian Drinking Water Guidelines			
	Group A	Group B	Group C	Group D
pH – Value at 25°C	6,0 – 9,0	5,5 – 9,5	4,0 – 11,0	4,0 – 11,0
Electrical Conductivity in mS/m at 25°C	150	300	400	400
Total Dissolved Solids at 180°C *				
Suspended Solids at 105°C *				
Total Alkalinity as $CaCO_3$				
Chloride as Cl *	250	600	1200	1200
Sulfate as SO_4	200	600	1200	1200
Fluoride as F	1.5	2.0	3.0	3.0
Nitrate as N *	10	20	40	40
Ortho Phosphate as P *				
Free & Saline Ammonia as N *	1.0	2.0	4.0	4.0
Sodium as Na	100	400	800	800
Potassium as K	200	400	800	800
Calcium as Ca	375	500	1000	1000
Magnesium as Mg	70	100	200	200
Total Organic Carbon as C [s]				
Chemical Oxygen Demand as O_2 (Total) *				
Aluminium as Al	0.15	0.50	1.0	1.0
Arsenic as As *	0.10	0.30	0.60	0.60
Cadmium as Cd	0.010	0.020	0.040	0.040
Total Chromium as Cr	0.10	0.20	0.40	0.40
Copper as Cu	0.50	1.0	2.0	2.0
Iron as Fe	0.10	1.0	2.0	2.0
Lead as Pb	0.050	0.10	0.20	0.20
Manganese as Mn	0.050	1.0	2.0	2.0
Mercury as Hg *	0.0050	0.010	0.020	0.020
Nickel as Ni	0.25	0.50	1.0	1.0
Uranium as U	0.030 * (WHO, 2011)			
Zinc as Zn	1.0	5.0	10	10

TABLE 4-3: WATER QUALITY ANALYSIS FOR BOREHOLE AT NBL IN 2016

	WW 204636		WW 204633		WW 204637		WW 204634		WW 204635	
Parameter	Value	Group	Value	Group	Value	Group	Value	Group	Value	Group
	7.6	A	7.0	A	7.1	A	7.2	A	7.2	A
Electrical Conductivity	279.2	B	188.9	B	192.2	B	302	C	167.5	B
Turbidity	1.7	B	8.1	C	10	C	14	D	34	D
Colour	17	A	57		57		184		133	
Total Dissolved Solids (ca)	1871		1266		1288		2023		1122	
Total Alkalinity as $CaCO_3$	594		664		588		591		604	
Total Hardness as $CaCO_3$	331	B	229	A	271	A	362	B	191	A
Ca-Hardness as $CaCO_3$	150	A	130	A	160	A	152	A	112	A
Mg-Hardness as $CaCO_3$	181	A	99	A	111	A	210	A	78	A
Chloride as Cl^-	209	A	80	A	117	A	258	B	55	A
Fluoride as F^-	3.4	D	4.7	D	5.5	D	4.0	D	4.5	D
Sulphate as SO_4^{2-}	579	B	267	B	273	B	672	C	208	B
Nitrate as N	2.0	A	<0.5	A	<0.5	A	<0.5	A	<0.5	A
Nitrite as N	<0.1		<0.1		<0.1		<0.1		<0.1	
Sodium as Na	474	C	346	B	326	B	580	C	292	B
Potassium as K	65	A	44	A	46	A	79	A	43	A
Magnesium as Mg	44	A	24	A	27	A	51	A	19	A
Calcium as Ca	60	A	52	A	64	A	61	A	45	A
Manganese as Mn	0.11	B	0.09	B	0.06	B	0.17	B	0.15	B
Iron as Fe	0.47	B	0.72	B	0.95	B	0.34	B	3.6	D
Cyanide as CN^-	0.01	A	0.01	A	<0.01	A	<0.01	A	0.01	A
Cadmium as Cd	<0.01	f	<0.01	f	<0.01	f			<0.01	f
Chromium as Cr	<0.01	A	<0.01	A	<0.01	A			<0.01	A
Mercury as Hg	<0.01	g	<0.01	g	<0.01	g			<0.01	g
Lead as Pb	0.01	A	<0.01	A	0.04	A			0.01	A
Arsenic as As	0.01	A	0.05	A	0.06	A			0.03	A
Selenium as Se	0.03	A	0.14	D	0.15	D			0.09	C
Zinc as Zn	0.02	B	<0.01	B	0.01	A			0.02	A
Copper as Cu	0.02	A	0.01	A	0.01	A			<0.01	A
Nickel as Ni	<0.01	A	<0.01	A	<0.01	A			<0.01	A
Cobalt as Co	<0.01	A	<0.01	A	<0.01	A			<0.01	A
Aluminium as Al	0.06	A	0.14	A	0.01	A			0.02	A
Silica as Si	23		25		25				27	

4.3 Groundwater Monitoring At NBL

The boreholes are installed with a telemetry SCADA monitoring system that is remotely controlled from a control room. Ever since the commissioning of the boreholes in 2016, the groundwater abstraction, groundwater levels and the pump water levels have been monitored to date by this system. The Figure 4-1 and Figure 4-2 reveal the pumped volume and subsequent groundwater levels from May 2016 to July 2019. Monitoring still continues. These pumped volumes and groundwater levels are submitted to DWAF in the form of abstraction returns as part of the permit conditions. This practise is done on a quarterly basis, although the information submitted must reflect the monthly recording of these parameters.

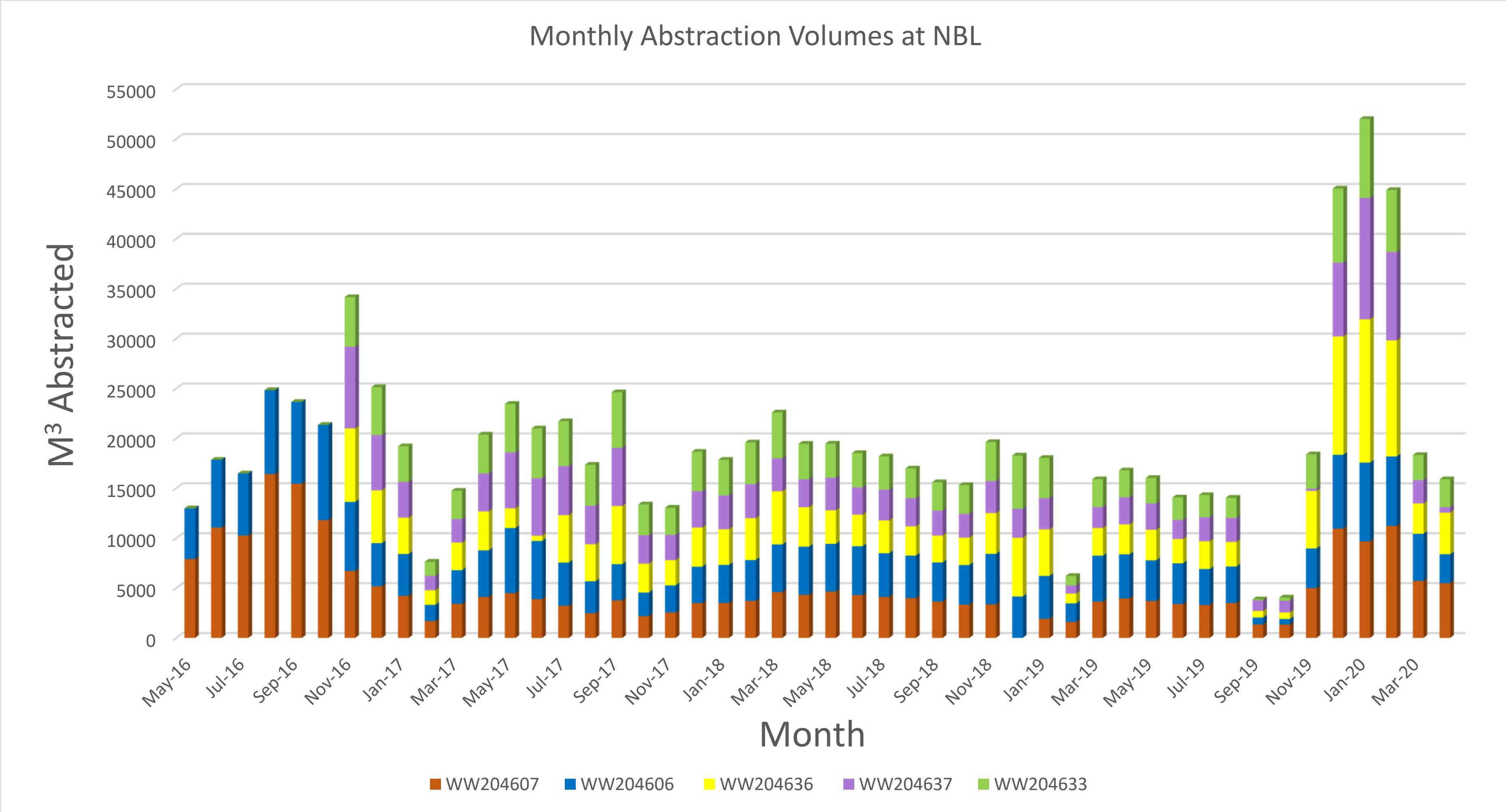

FIGURE 4-1: MONTHLY ABSTRACTION VOLUMES AT NBL

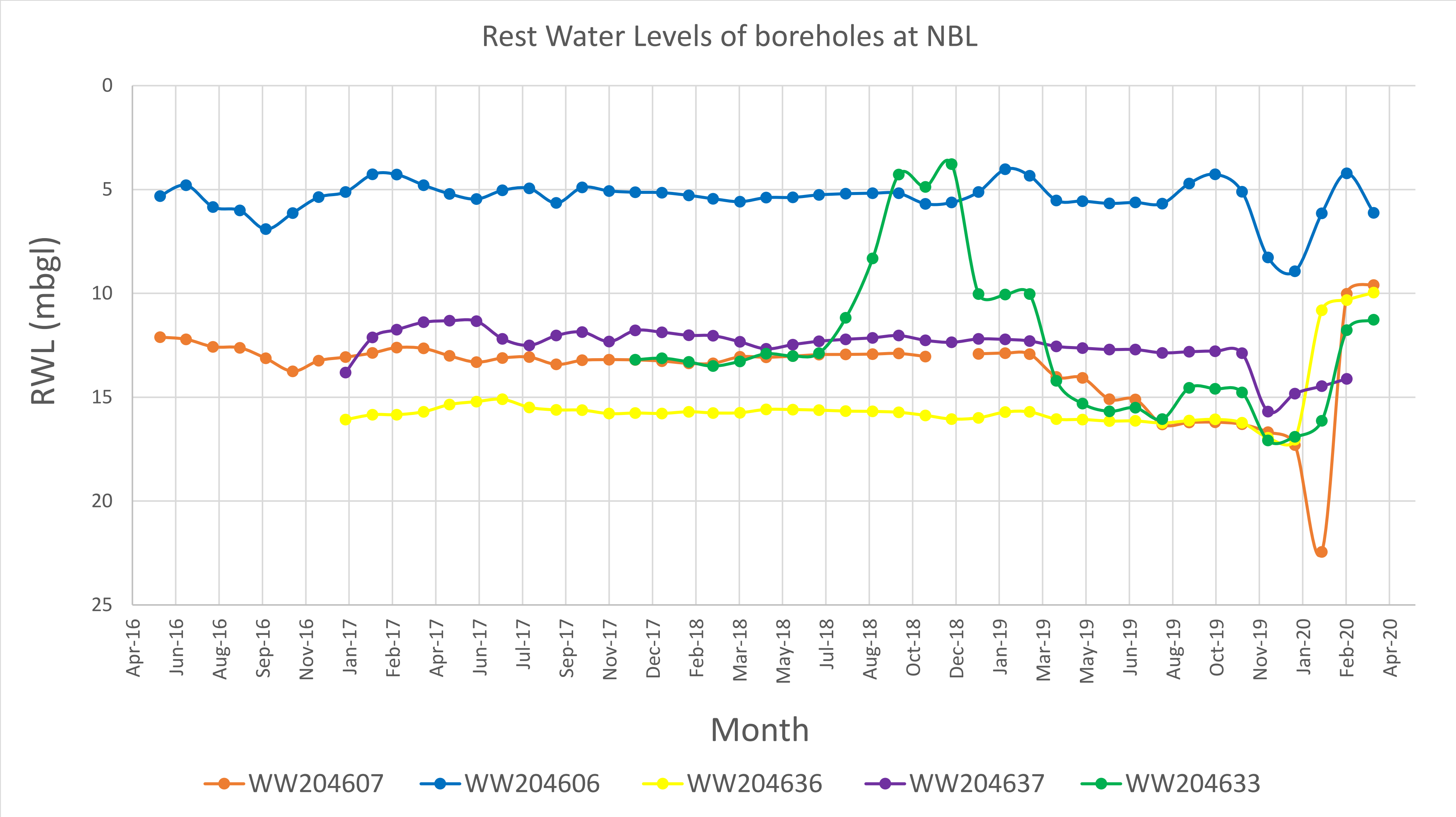

FIGURE 4-2: MONTHLY WATER LEVELS FOR THE RESPECTIVE BOREHOLES NBL

5 Environmental Impact Assessment

This chapter presents the assessment of the potential impacts of groundwater abstraction activities by NBL within the permitted threshold of 766 500 m^3/a, and includes potential risks that may result from infrastructure where relevant in close proximity to the boreholes.

5.1 INTRODUCTION

NBL continues to monitor its groundwater abstraction activities and has developed infrastructure within the brewery's premises to prevent the risk of ground water pollution from the brewery's operational activities and the groundwater abstraction.

However, the future projected bulk abstraction levels up to the volume of 766 500 m^3/a though permitted, may result in long term potential impacts on the water levels of the WNA which other industrial users are simultaneously abstracting from. SLR undertook an Aquifer Sustainability Assessment Study (Appendix 3) to investigate the water supply potential of the aquifer underlying the NBL premises and associated impacts on other industrial users' abstraction activities.

SLR developed a numerical groundwater model in MODFLOW-2005 code with confidence level of 'Class 1' to 'Class 2' according to the Australian groundwater modelling guidelines. The model substantiated the proposed abstraction volume and forms the basis of the current ground water permit no. 11149 a planning and aquifer management tool for NBL. Various groundwater abstraction scenarios were modelled and subsequent long term water level drawdowns simulated, which also considers abstraction by other users. The prediction results show that Scenarios A and B, abstraction of 800 m^3/d and 2,100 m^3/d respectively, from NBL production boreholes are sustainable in the long term, while Scenario C (long term projected water demand of the beverage plant of 3,000 m^3/day) is sustainable only in the short term.

5.2 METHODOLOGY

The criteria used to assess the impacts and the method of determining the significance of the impacts is outlined in Table 5-1 this method complies with the Environmental Impact Assessment Regulations (Government Gazette No. 4878). Part A provides the approach for determining impact consequence (combining severity, spatial scale and duration) and impact significance (the overall rating of the impact). Impact consequence and significance are determined from Part B and C. The interpretation of the impact significance is given in Part D. Both mitigated and unmitigated scenarios are considered for each impact.

The management and mitigation measures to address the identified impacts are included in the EMP in Section 7.

TABLE 5-1: CRITERIA FOR ASSESSING IMPACTS

Note: Both the criteria used to assess the impacts and the methods of determining the significance of the impacts are outlined in the following table. Part A provides the definition for determining impact consequence (combining severity, spatial scale and duration) and impact significance (the overall rating of the impact). Impact consequence and significance are determined from Part B and C. The interpretation of the impact significance is given in Part D.

PART A: DEFINITION AND CRITERIA*		
Definition of SIGNIFICANCE		**Significance = consequence x probability**
Definition of CONSEQUENCE		**Consequence is a function of severity, spatial extent and duration**
Criteria for ranking of the SEVERITY/NATURE of environmental impacts	**H**	Substantial deterioration (death, illness or injury). Recommended level will often be violated. Vigorous community action. Irreplaceable loss of resources.
	M	Moderate/ measurable deterioration (discomfort). Recommended level will occasionally be violated. Widespread complaints. Noticeable loss of resources.
	L	Minor deterioration (nuisance or minor deterioration). Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints. Limited loss of resources.
	L+	Minor improvement. Change not measurable/ will remain in the current range. Recommended level will never be violated. Sporadic complaints.
	M+	Moderate improvement. Will be within or better than the recommended level. No observed reaction.
	H+	Substantial improvement. Will be within or better than the recommended level. Favourable publicity.
Criteria for ranking the DURATION of impacts	**L**	Quickly reversible. Less than the project life. Short term
	M	Reversible over time. Life of the project. Medium term
	H	Permanent. Beyond closure. Long term.
Criteria for ranking the SPATIAL SCALE of impacts	**L**	Localised - Within the site boundary.
	M	Fairly widespread – Beyond the site boundary. Local
	H	Widespread – Far beyond site boundary. Regional/ national

PART B: DETERMINING CONSEQUENCE					
SEVERITY = L					
DURATION	Long term	**H**	**Medium**	**Medium**	**Medium**
	Medium term	**M**	**Low**	**Low**	**Medium**
	Short term	**L**	**Low**	**Low**	**Medium**
SEVERITY = M					
DURATION	Long term	**H**	**Medium**	**High**	**High**
	Medium term	**M**	**Medium**	**Medium**	**High**
	Short term	**L**	**Low**	**Medium**	**Medium**
SEVERITY = H					
DURATION	Long term	**H**	**High**	**High**	**High**
	Medium term	**M**	**Medium**	**Medium**	**High**
	Short term	**L**	**Medium**	**Medium**	**High**
			L	**M**	**H**
			Localised Within site boundary Site	Fairly widespread Beyond site boundary Local	Widespread Far beyond site boundary Regional/ national
			SPATIAL SCALE		
PART C: DETERMINING SIGNIFICANCE					
PROBABILITY (of exposure to impacts)	Definite/ Continuous	**H**	**Medium**	**Medium**	**High**
	Possible/ frequent	**M**	**Medium**	**Medium**	**High**
	Unlikely/ seldom	**L**	**Low**	**Low**	**Medium**
			L	**M**	**H**
			CONSEQUENCE		

PART D: INTERPRETATION OF SIGNIFICANCE	
Significance	**Decision guideline**
High	It would influence the decision regardless of any possible mitigation.
Medium	It should have an influence on the decision unless it is mitigated.
Low	It will not have an influence on the decision.

***H = high, M= medium and L= low and + denotes a positive impact.**

5.3 ASSESSMENT OF IMPACTS

5.3.1 Issue: The accidental spill of hydrocarbons impacting on groundwater quality

Introduction

The location of the groundwater boreholes (WW 204606, WW 204607, WW 204633, WW 204636 and WW 204637) are distant from operational activities that may involve machinery which could cause a hydrocarbon spill and lead to pollution of the water resource. Each borehole except for WW 204634 (Monitoring borehole) and WW 204635 (Standby production borehole) is housed in a metallic container with semi-permeable wooden floors. The likelihood of hydrocarbon spills incidents happening in these specific areas from operational vehicles/ equipment and Light Diesel Vehicles (LDV) is Low. It must be taken into consideration that both boreholes (WW 204634 and WW 204635) have un- restricted access as they are not locked and remain open to vandalism.

All the boreholes, excluding the standby and monitoring borehole aforementioned, are fitted with electric pumps and not diesel engines and they are remotely controlled and therefore operational and maintenance activities that could subsequently result in hydrocarbon spillages onto soils are not likely. No evidence of any spillages or soil contamination by hydrocarbons was observed at any of the borehole sites. Surface and groundwater quality could be compromised by hydrocarbon spills, depending on the magnitude of spill. Given the low likelihood of the primary cause (i.e. spillages outside of the production plant and storm water control areas) an impact on water quality is highly unlikely. The risk could be avoided with mitigations detailed in Section 6.

Severity:

Once hydrocarbons have entered the hydrological cycle, their elimination is difficult, and in most places impossible, especially with groundwater. Many of the components of hydrocarbons are toxic and their presence in groundwater could have deleterious effects for groundwater users that do not treat the water prior to utilisation. NBL has developed infrastructure that avoids any likelihood of hydrocarbon contamination. The severity of the impact is high in unmitigated cases, whereby recommended concentrations will often be exceeded, and low in the mitigated scenario.

Spatial Scale:

The impact would extend beyond the site boundary as contamination transport is expected to be widespread, though local, following the groundwater flow patterns, hence medium influence in both the unmitigated and mitigated cases.

Duration:

The duration of pollution is continuous therefore the impact duration is high in the unmitigated and medium in the mitigated scenarios.

Consequence:

In the unmitigated scenario, the consequence of the potential impact is medium and this reduces to low with mitigation.

Probability:

Probability of occurrence is medium in the unmitigated case and low in the mitigated case.

Significance:

The significance of this potential impact is medium in the unmitigated scenario and low for the mitigated scenario. Refer to Section 6 for the management and mitigation measures.

TABLE 5-2: TABULATED SUMMARY OF THE ASSESSED IMPACT - THE IMPACT OF ACCIDENTAL SPILLS OF HYDROCARBONS ON GROUNDWATER QUALITY

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of occurrence	Significance
Unmitigated	H	H	M	M	M	M
Mitigated	L	M	M	L	L	L

5.3.2 Issue: Accidental leakage from underground fuel storage on groundwater quality

Introduction

This Environmental Performance Report and Management Plan (EMP) presents the current status of NBL's groundwater monitoring programme and documents a series of management plans (MPs) which are designed to meet legal requirements as well as avoid, minimise or mitigate the impacts associated with the abstraction of groundwater at the NBL premises. The EMP gives the commitments, which form the 'environmental contract' between NBL and the Government of the Republic of Namibia; represented by the Ministry of Environment and Tourism (MET).

The EMP scope is limited to the groundwater abstraction activities and associated infrastructure. The underground fuel storage facility is not related to the abstraction activities. However, it has been identified that all hazardous storage facilities at NBL have a potential risk of polluting groundwater in the aquifer. In the event of leakage, fuel from the underground fuel storage facility could enter and pollute groundwater.

- The underground Fuel Storage Facility;

The underground fuel storage facility is located next to the source warehouse tents. It consists of two 14 m3 composite steel tanks, as per Ministry of Mines and Energy standards. One tank is for diesel and another for petrol. The tanks are compacted with sand/ground and covered with concrete. The diesel tank is refuelled once a month and the petrol tank is refuelled once every three to four months. Given the hydrogeological setup onsite where the water is found in quartzitic-schist fractures, should leakages or spills occur at the underground storage facilities, the fractures may act as conduits to further relay the spills to the downstream boreholes. Groundwater quality could be compromised by hydrocarbon spills, depending on the magnitude of spill. The risk could be avoided with mitigations detailed in the operation control measures.

Assessment of Impact

Severity:

Once hydrocarbons enter a fractured aquifer, their elimination is difficult, and in most instances impossible. Many of the components of hydrocarbons are toxic and their presence in groundwater could have deleterious effects for groundwater users. The severity would depend on the volume of spill or leakage.

The NBL infrastructure meets industry standards and is subject to regular pressure testing that limits the likelihood of hydrocarbon leakage from the underground storage facility. Sound operating practices and stock control limits the risk of spillage and response planning would further restrict severity in the event of a spill. The severity of the impact is high in unmitigated cases, as leaked hydrocarbons would cause a substantial deterioration of the groundwater and the act cannot be reversed, and low in the mitigated scenario.

Spatial Scale:

The impact would extend beyond the site boundary as contaminant transport is expected to be fairly widespread but local, following the groundwater flow patterns. The spatial extent would also be influenced by the volume of spill or leakage. The The spatial influence is medium in unmitigated cases, but due to the mitigations of regular inspection and maintenance, good house-keeping and response planning, the impact is low in mitigated cases.

Duration:

The duration of pollution risk is continuous, permanent and long term, therefore the impact duration is high in the unmitigated and the mitigated scenarios.

Consequence:

In the unmitigated scenario, the consequence of the potential impact is high, widespread downstream of the site boundary and this reduces to low impact with mitigation.

Probability:

Probability of occurrence is low as the tanks are engineered to prescribed standards and subject to regular testing. The various inspection and stock control methods should enable detection of leaks. Good house-keeping, personnel training and response planning limits spillage.

Significance:

The significance of this potential impact is medium in the unmitigated scenario and low for the mitigated scenario. Refer to Section 6 for the management and mitigation measures.

TABLE 5-3: TABULATED SUMMARY OF THE ASSESSED IMPACT - THE IMPACT OF ACCIDENTAL LEAKAGE FROM UNDERGROUND FUEL STORAGE ON GROUNDWATER QUALITY

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of occurrence	Significance
Unmitigated	H	H	M	H	L	M
Mitigated	L	H	L	M	L	L

5.3.3 Issue Over abstraction of groundwater on the WNA

Introduction

To assess the sustainability of the WNA, both changes in water levels and mass balances, due to different groundwater abstraction rates need to be considered. If water level changes are acceptable and mass balances to steady state conditions indicate a balanced outflow and inflow, the modelled scenarios may be sustainable in regards to the aquifer yield.

A total of three predictive scenarios (A, B and C) were modelled to calculate the drawdown associated with different abstraction volumes. The scenarios are described below.

Scenario A: This scenario is designed to show changes to the hydrogeological system due to long term abstraction of the previously licensed volumes (NBL: 800 m^3/day, plus a combined volume of other users: 1,595.4 m^3/d).

Scenario B: This scenario is designed to show changes to the hydrogeological system due to planned increased abstraction with NBL abstraction according to the DWAF letter dated Nov 2016 (NBL: 2,100 m^3/day, other users: 1,595.4 m^3/d).

Scenario C: This scenario is designed to show changes to the hydrogeological system due to long term abstraction including NBL's long term projected water demand (NBL: 3,000 m^3/day, other users: 1,595.4 m^3/d).

The increase in groundwater abstraction is expected to cause groundwater depressurisation and, therefore, drawdown (water level decline). The predicted extent of groundwater drawdown is described below for each Scenario. (Refer to Figure 5-1; Figure 5-2; Figure 5-3; Figure 5-4; and Figure 5-5)

Scenario A: The highest predicted long term drawdown of up to 25 m is predicted in the area of the CCNBC boreholes. This is likely to be due to the low hydraulic conductivity as well as the fact, that no abstraction was applied to the calibration scenario for these boreholes. In the vicinity of the NBL boreholes, the predicted drawdown is up to 15 m at WW204430 (Namibia Construction), between 5 and 10 m at the southern boreholes (WW204636 and WW204606) and between 10 and 15 m in the area of the remaining NBL boreholes.

The effect of the hydraulic barrier, separating the aquifer west of the valley and highly fractured zone, can be seen. The drawdown does not extend to the southwestern no flow boundary, however, drawdown is modelled at the western no flow boundary.

Figure 5-1 shows the drawdown as a result of increased abstraction rates of the NBL boreholes only. The north – south extent of the 5 m drawdown contour is approximately 4 km.

Scenario B: The highest predicted long term drawdown of up to 45 m is predicted in the area of the CCNBC boreholes as well for WW204430 (Namibia Construction). In the vicinity of the NBL boreholes, the predicted drawdown is generally between 40 m to 45 m and 35 m to 40 m at the southern boreholes (WW204636 and WW204606 respectively).

Figure 5-2 shows the drawdown as a result of increased abstraction rates of the NBL bores only. The north – south extent of the 5 m drawdown contour is approximately 8 km.

Scenario C: The highest predicted long term drawdown of up to 70 m is predicted in the area of the NBL owned boreholes as well for borehole WW204430 (Namibia Construction). In the vicinity of the CCNBC boreholes, the predicted drawdown is largely between 50 m and 55 m. The drawdown at the NamPower boreholes is predicted to be between 55 m and 65 m. The hydraulic effect of the barrier separating the aquifer west of the valley and the highly fractured zone in the centre of the valley can clearly be seen. The 5 m drawdown contour partly extends to the southwestern no flow boundary. Drawdown of up to 45 m is modelled at the western no flow boundary. Figure 5-3 shows the drawdown as a result of increased abstraction rates of the NBL boreholes.

Based on the numerical model, the WNA can sustainably yield the required abstraction rates on all included groundwater users in the study area (model domain) with the effects of water level reductions with steady state predicted drawdown of up to 70 m in parts of the area and only in Scenario C.

Figure 5-6 shows the expected long term (steady state) water level drawdown for the three different abstraction scenarios, i.e. 800 m^3/day (Scenario A, current abstraction- blue line), 2,100 m^3/day (Scenario B, planned future abstraction - green line) and 3,000 m^3/day (Scenario C, projected future water demand of NBL supplied from boreholes only – grey line).

For Scenarios A and B the water levels are predicted to remain above the uppermost water strikes in NBL production boreholes, while water levels for Scenario C fall locally below water strikes, which means that some faults will be dewatered at that pumping rate and that the yield of that particular borehole (WW204606) might be reduced or the production borehole might even be dewatered.

- Groundwater level monitoring has shown that the current abstraction (Scenario A) result in a sustainable water level decline over the observation period of approximately one year.
- The numerical groundwater modelling of three abstraction scenarios has shown that abstraction from the WNA is sustainable in the medium to long term for Scenarios A and B, and for Scenario C only in the short term.
- The uncertainties of the model are relatively high due to a lack of monitoring data (the WNA was only developed recently) and groundwater monitoring must continue for future calibration of the model and aquifer management purposes. The results of the steady state groundwater flow model are considered to be conservative and are for worst case scenarios.
- SLR is in the process of providing an update of the groundwater flow model and a conversion into transient stage, which will include all the groundwater monitoring undertaken since the last model and provide a more realistic impact of the planned abstraction on groundwater levels. First results show that the impact will be less severe than described in the above paragraphs and that both abstraction scenarios A and B are sustainable.

The following sections assess the significance of impact related to the proposed abstraction and projected abstraction volume, based on the conservative (worst case) steady state groundwater flow model.

Assessment of Impact

Severity:
When groundwater is over-exploited, water levels will decline and continue to do so until they either stabilize at a lower level or, if abstraction is persistently greater than recharge, the aquifer is dewatered.

The Aquifer Sustainability Assessment through means of the model indicated that the cumulative groundwater abstraction for Scenario A results in a sustainable water level decline, which is sustainable in the medium to long term for Scenarios A and B, and for Scenario C only in the short term. The abstraction permit is only valid up to the abstraction Scenario B for a period of one year, therefore the severity is rated as medium in unmitigated and low in mitigated scenarios.

Spatial Scale:

Refer to Figure 5-1 to Figure 5-5 for illustration of the radius of influence from the predicted abstraction scenarios. There is no significant difference in the radius of influence for predicted abstraction scenarios A and B. The abstraction of water for scenario A is predicted to have a radius of influence that can reach slightly into neighboring farmers, therefore medium in unmitigated scenario and low in a mitigated scenario.

For scenario C it can be seen, that the flow direction may change in the center of the valley north of the NBL area. The radius of influence is of much greater extent. Therefore the spatial scale can be rated medium in unmitigated scenario and low in a mitigated scenario.

Duration:

Any effect of over abstraction is reversible and could revert back to natural conditions once pumping stops for prolonged periods and efficient time is given for aquifer recharge. However, abstraction from the WNA is sustainable in the medium to long term for Scenarios A and B, and for Scenario C only in the short term. Therefore can be rated medium in unmitigated scenario and low in the mitigated.

Consequence:

In the unmitigated scenario, the consequence of the potential impact is medium to high. This is reduced to low with mitigation.

Probability:

Probability of occurrence is medium in the unmitigated case and low in the mitigated case.

Significance:

The significance of this potential impact is medium in the unmitigated scenario and low for the mitigated scenario. Refer to Section 7 for the management and mitigation measures.

TABLE 5-4: TABULATED SUMMARY OF THE ASSESSED IMPACT – OVER ABSTRACTION OF GROUNDWATER ON THE WNA

Mitigation	Severity	Duration	Spatial Scale	Consequence	Probability of occurrence	Significance
Unmitigated	M	M	M	M-H	M	M
Mitigated	L	L	L	L	L	L

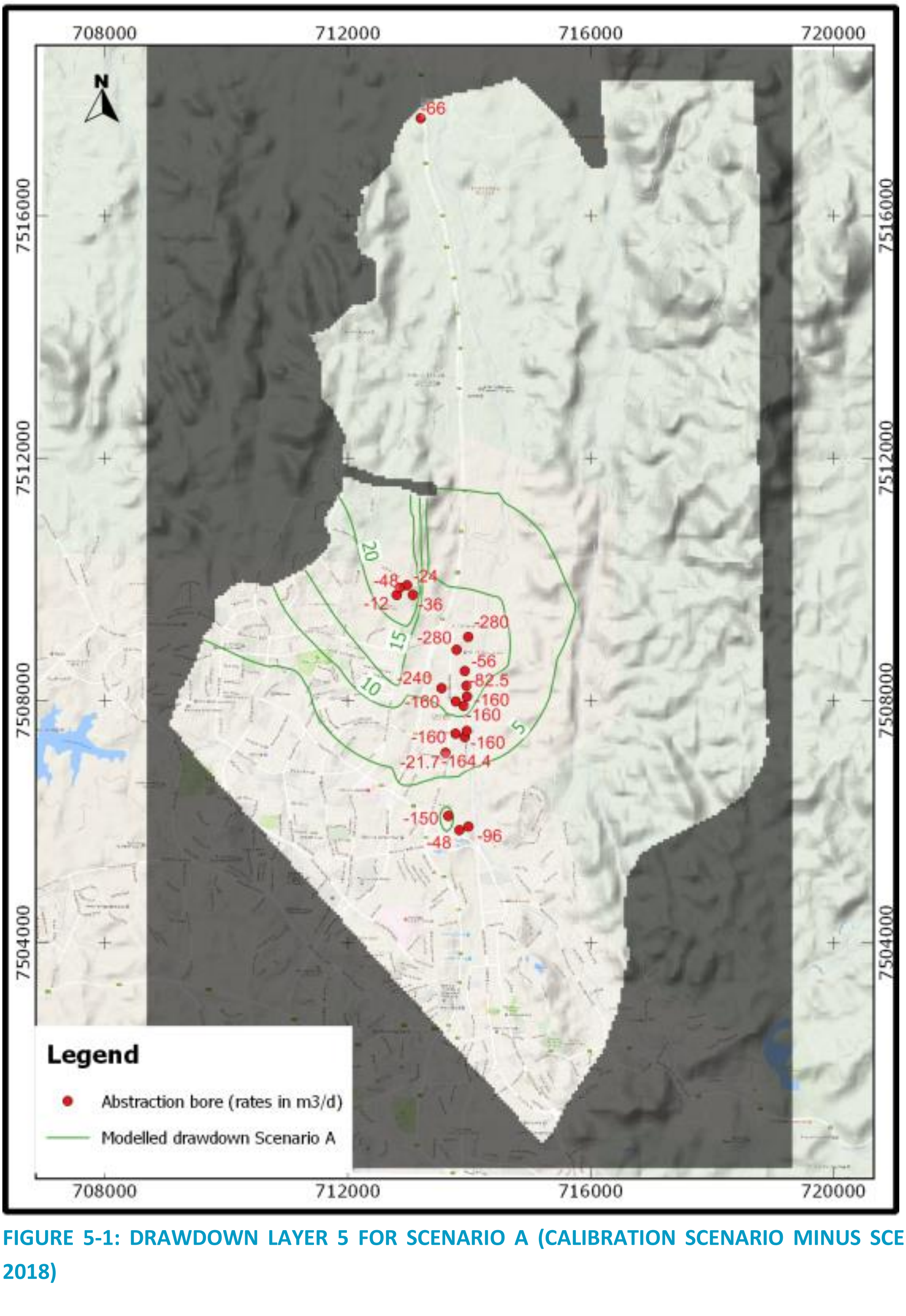

FIGURE 5-1: DRAWDOWN LAYER 5 FOR SCENARIO A (CALIBRATION SCENARIO MINUS SCENARIO A) (SLR, 2018)

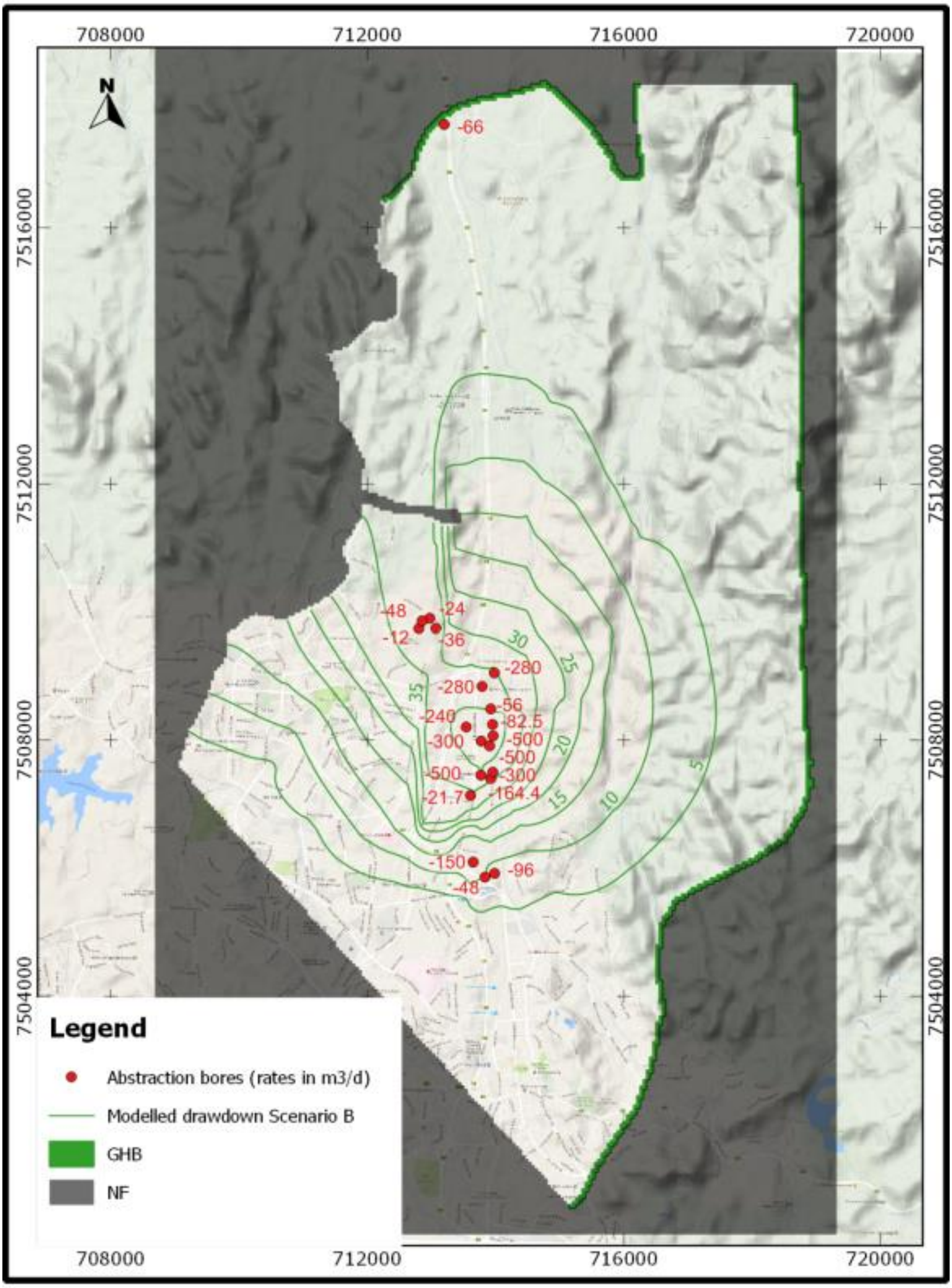

FIGURE 5-2: DRAWDOWN IN LAYER 5 FOR SCENARIO B (CALIBRATION SCENARIO MINUS SCENARIO B) (SLR, 2018)

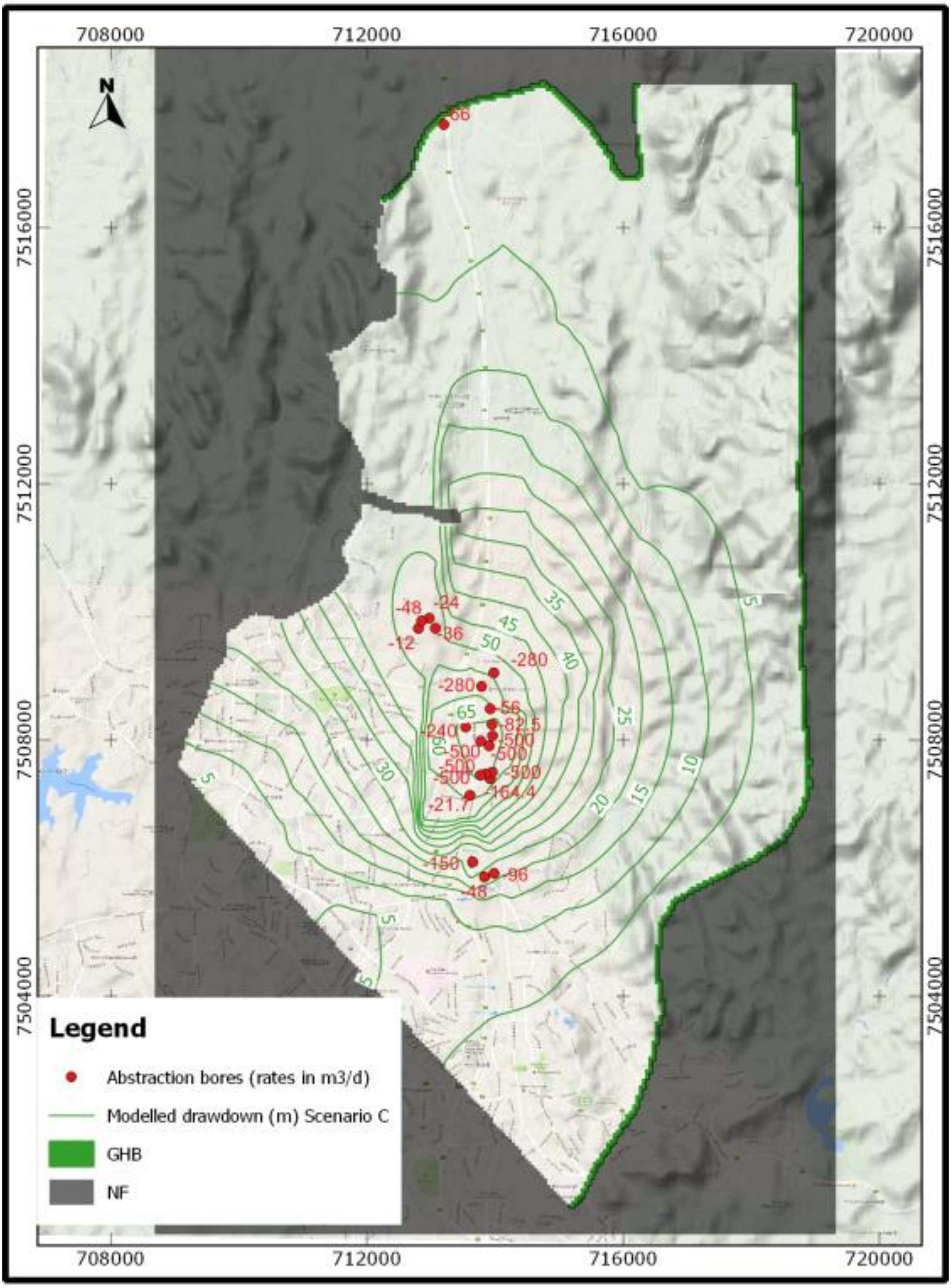

FIGURE 5-3: DRAWDOWN IN LAYER 5 FOR SCENARIO C (CALIBRATION SCENARIO MINUS SCENARIO C)

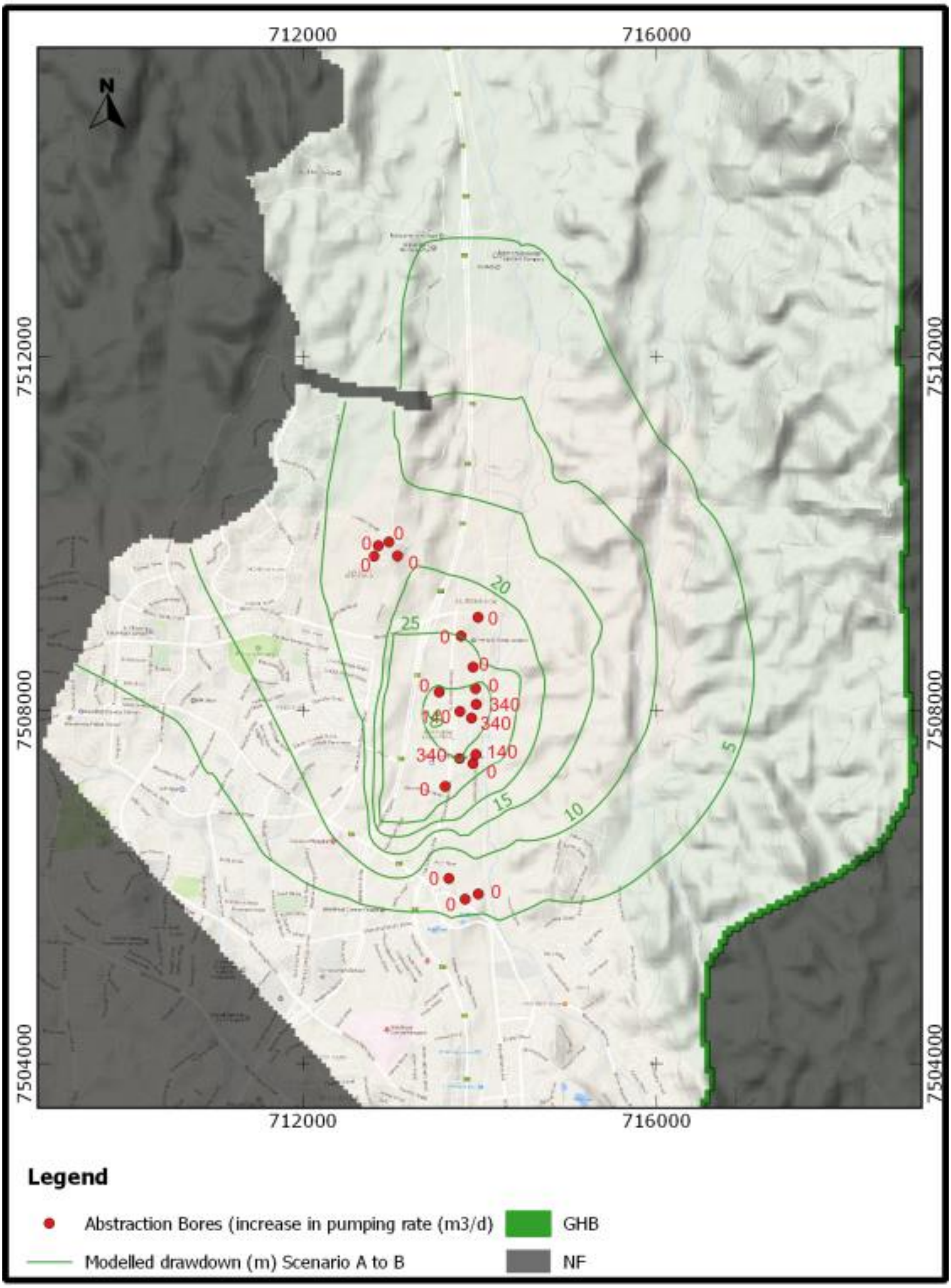

FIGURE 5-4: DRAWDOWN IN LAYER 5 FOR SCENARIO B BASED ON ABSTRACTION INCREASE (SCENARIO A TO SCENARIO B)

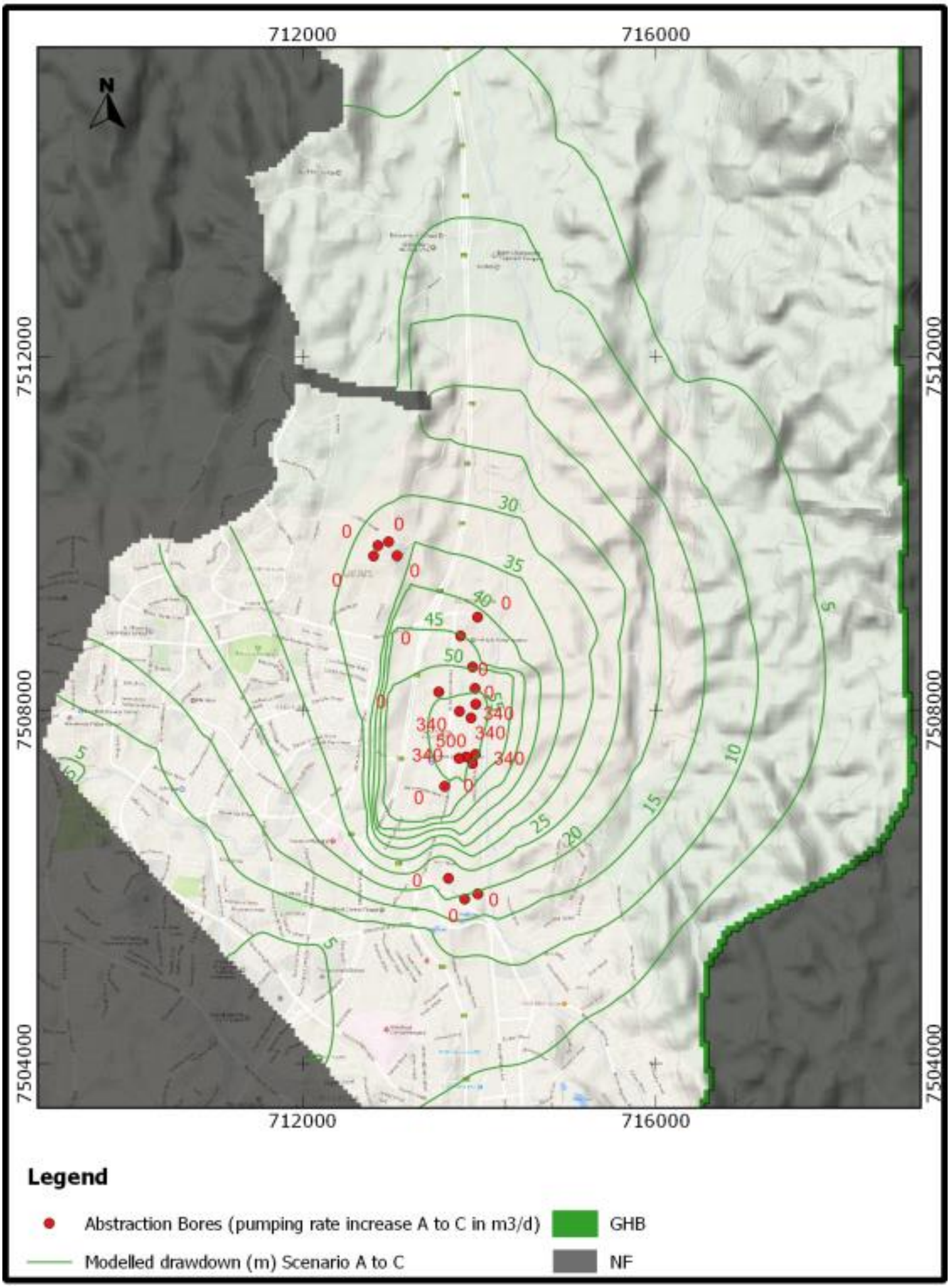

FIGURE 5-5: DRAWDOWN IN LAYER 5 FOR SCENARIO B BASED ON ABSTRACTION INCREASE (SCENARIO A TO SCENARIO C)

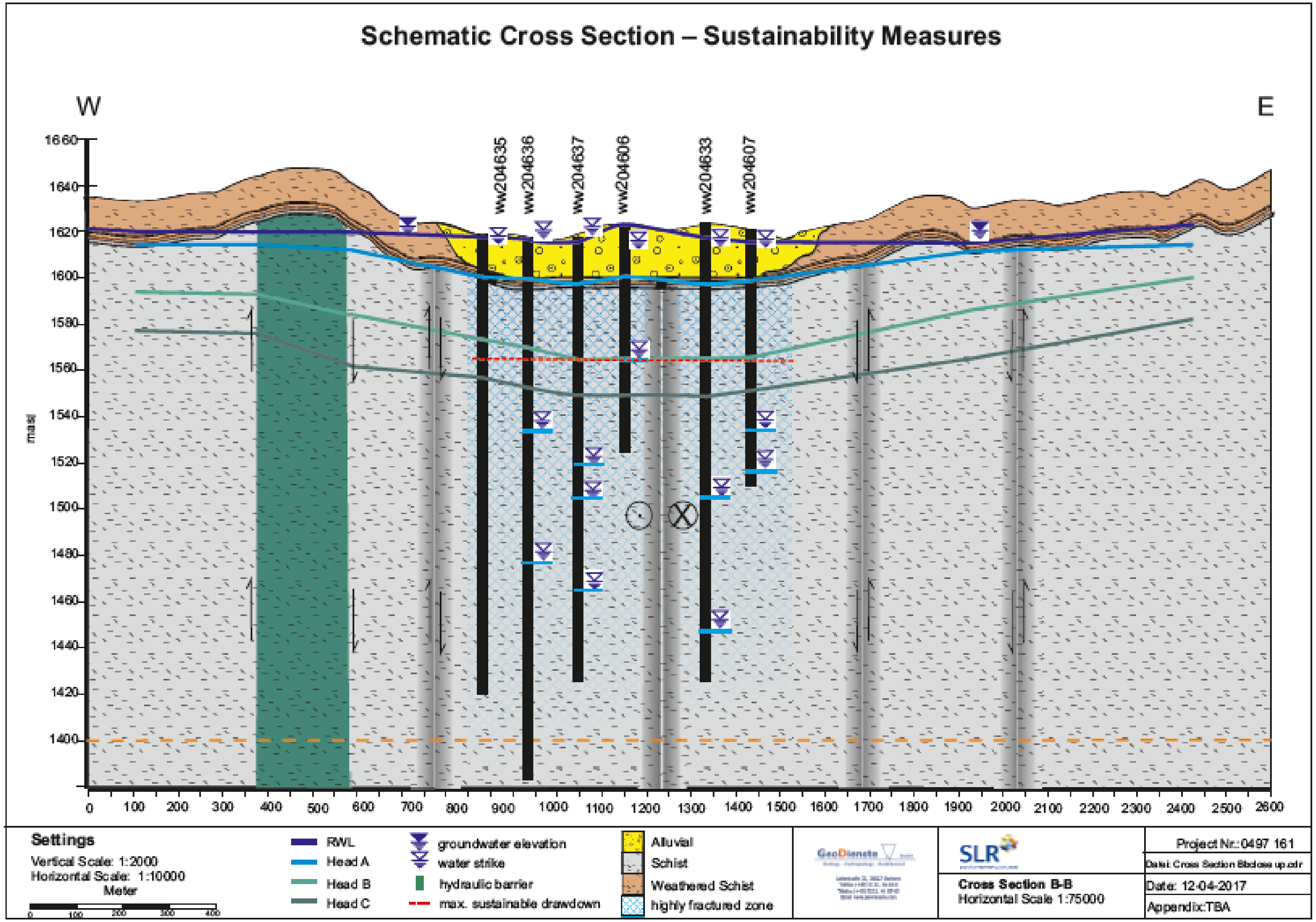

FIGURE 5-6: GROUNDWATER LEVEL DRAWDOWN FOR THE VARIOUS ABSTRACTION SCENARIOS FOR NBL BOREHOLES VS WATER STRIKE DEPTHS (AVAILABLE DRAWDOWN), (SLR, 2018)

6 MANAGEMENT PLANS

6.1 AIM

The aim of the Environmental Management Plan (EMP) is to detail the actions required to effectively implement mitigation and management measures. These actions are required to minimise negative impacts and enhance positive impacts associated with the groundwater abstraction activities.

The EMP gives the commitments, which forms the environmental contract between NBL and the Government of the Republic of Namibia; represented by the Ministry of Environment and Tourism. It is important to note that an EMP is a living document in that it will be updated and amended as new information (e.g. environmental data), policies, authority guidelines and technologies develop. The conceptual management measures proposed to mitigate the potential impacts are detailed in the action plans below.

6.2 ACTION PLANS TO ACHIEVE OBJECTIVES

Action plans to achieve the objectives are listed in tabular format together, separated by activities. The action plans also include the frequencies for implementing the mitigation measures as well as identifying the responsible parties, refer to Table 6-1 to Table 6-3.

6.3 PARTIES RESPONSIBLE FOR THE IMPLEMENTATION OF THE EMP

This section describes the roles and responsibilities for implementing the various management plans.

6.3.1 General Manager

The General Manager has overall responsibility for environmental management and for ensuring this EMP is implemented. The General Manager must ensure the Environmental Management Plan is included in all contracts and to ensure that contractors adhere to the conditions of the EMP.

Contract documents should consider the inclusion of penalties for non-conformance to the EMP, or to link the sign off of the Contract to a retainer clause.

Ideally the Environmental Manager will be responsible for the following aspects related to compliance of this EMP:

- Regular inspections and auditing compliance to this EMP and any other relevant legal requirements e.g. permits and authorisations
- Conduct environmental awareness training during induction training and on an ad hoc basis thereafter
- Conduct scheduled monitoring as outlined in Section 7 as well as any additional monitoring required by permit and authorisations issued to NBL by relevant authorities
- Submit required information to relevant authorities such as reporting related to monitoring and with regard to compliance with the EMP, permit and relevant authorisations
- Liaise with NBL Management and various external stakeholders such as CoW and MET on environmental management.

6.3.2 External Specialists

NBL may appoint external environmental specialists, as and when required, to assist with the implementation of certain commitments made in the various management plans this may include tasks such as auditing the implementation of the EMP.

TABLE 6-1: MITIGATION ACTIONS RELATED TO GROUNDWATER CONTAMINATION

Activities / facilities	Potential Impact	Management and mitigation measures	Action plan	
			Frequency / target date	Responsible parties
Hydrocarbons from; vehicles, machinery, wash bay and equipment on NBL premises.	Soil and groundwater contamination	• NBL should assess and ensure that all operational activities on site are not likely to give rise to soil contamination that could further lead to groundwater pollution. • Regular environmental awareness should include potential risks associated with hydrocarbons especially around borehole WW 204634 located by the logistic truck centre and loading zone. • Vehicles, machinery and equipment shall be kept in good working condition to ensure they do not leak oil/diesel. Vehicles and machinery shall be serviced in designated servicing bays/ area located as far as possible from the borehole sites in accordance with manufacturers recommendations. However, in the event that machinery needs to be repaired/serviced close to the boreholes, all care shall be taken to prevent spillage of oil/diesel by performing the work on impermeable surfaces such as drip trays.All used parts from vehicles and machinery (which may include, but not limited to, oil filter, pipes, rags, cans, etc.) shall be collected and removed from site and disposed of in an appropriate manner. • All refuelling of vehicles shall take place on impermeable surfaces (bunding), andin their designate areas. • Drip trays must be used at all times when refuelling to contain any spills. • Any spills shall be contained and cleaned up immediately. • Spill kits shall be readily available on site. Employees will be trained in the use of the spill kits to enable containment and remediation of pollution incidents. • A Heavy Fuel Oil storage must be acquired to dispose of all HFO produced onsite. • NBL should ensure that, the current infrastructure at the production plant, including boreholes, includes protection measures against stormwater events • The scrapyard must be re-designed and an impermeable layer placed below the scrap	Daily	NBL, contractors of NBL, visitors

Activities / facilities	Potential Impact	Management and mitigation measures	Action plan	
Accidental leakage from underground fuel storage	Soil and groundwater contamination	• A procedure for tank filling, including measures to avoid spills, must be obtained from Engen and must be made available to IMS (Imperial Managed Solutions) fuel attendants and to NBL management. • Emergency spill protocol to be prepared and the fuel attendants to be trained sufficiently. Protocol to include emergency numbers and contact persons. • Spill kits shall be readily available on site. Employees to be trained in the use of the spill kits to enable containment and remediation of pollution incidents. • Any spills to be cleaned up immediately and any spills more than 200 L to be reported to the minister of Mines and Energy. • Tank pressure test must be conducted annually by qualified personnel and records kept. Tanks to be maintained if required. • Integrity tests of the tank to be conducted and recorded annually or as specified by the supplier, most especially after repairs and maintenance. • Quarterly fuel stock control to be conducted to ascertain possible leakages. • The quarterly groundwater quality monitoring of the nearest downstream borehole to include the testing for hydrocarbons. • Monthly visual inspection of fuel spots on the ground around the tanks. • Good housekeeping to be followed by tank filling agents, fuel attendants and customers of the fuel. • Tanks to have a high liquid level alarm. This should be tested regularly, at least quarterly.	Ongoing At an incident Annually Quarterly Monthly	NBL, IMS, Engen

TABLE 6-2: MITIGATION MEASURES RELATED TO GROUNDWATER ABSTRACTION AND ASSOCIATED ACTIVITIES

Activities / facilities	Potential Impact	Management and mitigation measures	Action plan	
			Frequency / target date	**Responsible parties**
Groundwater abstraction and monitoring.	Over abstraction/ unsustainable abstraction	• Water abstraction measures raised in the current groundwater abstraction permit should be translated into a procedure for water management and a water monitoring programme. • NBL should continue adherence to the management and mitigation measures relevant to the sustainability of groundwater as detailed in the groundwater investigation study completed by SLR (2018) these include the following: ○ The NBL groundwater monitoring program must be continued and the groundwater model should be updated and calibrated to transient conditions once 2 years' worth of data is available. • An update of the existing groundwater model should be done after every two years to confirm the aquifer capacity and sustainable long term abstraction rates. • Allocated annual groundwater abstraction volumes shall not be exceeded. • NBL shall be in possession of a valid groundwater abstraction permit at all times. • Water meter installations should be as per the groundwater abstraction permit conditions. • Groundwater abstractions rates and cumulative volumes must be recorded monthly. • Resting water levels of the pumped boreholes must be recorded monthly. The data will be used to determine changes in groundwater levels due to pumping for the brewery and for the water treatment plant and where required additional mitigation will be implemented in consultation with a specialist. The monitoring data must be submitted quarterly as part of the permit requirements of DWAF. • The data will also assist in accurate prediction of groundwater behavior through modelling. • Water shall be used efficiently and wastage shall be avoided. • All associated infrastructure such as pipes and taps should be inspected for leakages as per the plant inspection checklist, and repaired to limit water loss. • In the case where permitted water levels or those indicated in the SLR Groundwater study are exceeded; this should be reported immediately to the regulating authority.	Once off or as per valid groundwater abstraction permit conditions and the Sustainability Study	NBL

Activities /	Potential Impact	Management and mitigation measures	Action plan	
		• It is recommended that, should NBL require more groundwater than the threshold of 766 500 m^3/annum, a Water Source Vulnerability Assessment should be undertaken to assess cumulative impact on the water resource. A formal EIA process will then be undertaken for an application of an ECC. • Although all water abstracted from the boreholes is treated before use in the plant, a water quality analysis must be conducted quarterly to keep record of the borehole water quality and to ensure early detection of any potential leakages that may be from industries upstream. • Water samples will be preserved according to laboratory specifications; • Where practical, an accredited, commercial laboratory will undertake sample analyses; • Parameters to be monitored should be identified in consultation with a specialist in the field and/or the relevant authority; • If necessary, following the initial monitoring results, certain parameters may be removed from or added to the monitoring programme in consultation with a specialist and/or the relevant authority.		

TABLE 6-3: MITIGATION MEASURES RELATED TO BOREHOLES INFRASTRUCTURE (INCLUDING EQUIPMENT) AND ASSOCIATED ACTIVITIES

Activities / facilities	Potential Impact	Management and mitigation measures	Action plan	
			Frequency / target date	**Responsible parties**
Boreholes infrastructure and associated activities.	• Tampered/ vandalized borehole infrastructure. • Faulty SCADA / flow meter readings •	• Appropriately calibrate groundwater abstraction equipment – regular inspections and calibration of equipment should be undertaken in line with the equipment calibration/validation procedure. • Calibration certificates must be documented. • Regular inspection of water meters and sensors to ensure their functionality should be undertaken and compared to the automated readings on the SCADA System. • The SCADA System to have a back-up in case of system error • Ensure all borehole caps are locked and that dipper holes are also caped and locked. • Borehole areas are to be access controlled. • Access to the containers of boreholes should be by permission of the responsible parties managing the boreholes only, and a register to be kept for those accessing borehole. • No waste shall be stored or managed near to the borehole areas, a frequent inspection of the boreholes not in containers shall be done, especially WW 204634 and WW 204635. • All company policies related to waste management shall be adhered to. • The scrapyard around the borehole WW 204637 should be relocated, even though the boreholes have a concrete slab around them, the protection is limited. In the event of no relocation possible, an impermeable layer must be placed under the scrap, the layer must have sufficient height to collect rainwater that can be pumped or sucked out for disposal	Daily	NBL

7 MONITORING AND AUDITING

7.1 AUDITING COMPLIANCE OF THE EMP

The commitments contained in this EMP will, once an environmental clearance certificate has been obtained, be NBL's contractual agreement with the Namibian authorities for sound environmental management. All employees, contractors and sub-contractors and any visitors to site will be expected to comply with the commitments contained herein and therefore these commitments must be communicated to them.

The Environmental Manager / Officer will conduct monthly inspections and quarterly internal audits against the commitments in the EMP. The audit findings will be documented for both record keeping purposes and for informing continual improvement.

As a minimum, the following documents will be submitted to the MET:

- The bi-annual report required by the MET will be submitted every six months; and
- Monitoring reports will be provided to MAWF as per the permit requirements.

8 CONCLUSION

The Environmental Performance Report (including impact assessment) and EMP are based on findings observed during the site visit undertaken on the 02 August 2019 and the Aquifer Sustainability Assessment undertaken to investigate the sustainability of the Windhoek North Aquifer against the currently permitted future projection of groundwater abstraction and its possible impacts on the aquifer and supply to other industrial users.

The Aquifer Sustainability Assessment undertaken to substantiate the permitted 766 500 m^3/a included the following:

- Various groundwater abstraction scenarios were modelled and subsequent long term water level drawdowns simulated, considering also abstractions from other users.
- The prediction results show that Scenarios A and B, abstraction of 800 m^3/day and 2,100 m^3/day respectively from NBL production boreholes are sustainable in the long term, while Scenario C (long term projected water demand of the beverage plant of 3,000 m^3/day) is sustainable only in the short term.

SLR is of the opinion that the management and mitigation measures relevant to the groundwater abstraction activity and the associated infrastructure have been provided in the EMP in Section 6. It is recommended that a groundwater monitoring programme be continued.

Provided that management at NBL continues to manage and monitor the water abstraction activities and implement the management and mitigation measures raised in this report, there is no reason why the MET should not issue the required ECC.

UNSIGNED ELECTRONIC COPY

Ester Gustavo	Marvin Sanzila	Edward Perry
(Project Manager and Report Author)		(Approved Reviewer)

9 REFERENCES

SLR, 2018. Sustainability Study of the Windhoek North Aquifer, SLR Project No.: 733.14039.00005, Report No.: 2017-WG10, July 2018

10 APPENDICES

APPENDIX 1: NBL GROUND WATER ABSTRACTION PERMIT

APPENDIX 2: DESCRIPTION OF THE NBL BOREHOLE\ SITES

Production and monitoring Borehole Identification	Picture	Description of the borehole and associated infrastructure.
Borehole WW204637	 	Borehole WW204637 is located by the scrapyard, within the premises of the NBL brewery in lockable metal container. The container is slightly elevated on a concrete slab, and has wooden floor. An electric abstraction pump is installed for this borehole with the main switch securely locked within the container. The borehole is installed with a telemetry SCADA monitoring system that is remotely controlled from a control room and it accurately monitors the groundwater levels, pumping rates.

Borehole WW204633	 	Borehole WW204633 is a production borehole located within the fenced perimeter on the northern side of the brewery premises, along the main truck entrance. Access to the borehole is restricted with a lockable metal container built around it An electric abstraction pump is installed for this borehole with the main switch securely locked within the container. The borehole is installed with a telemetry SCADA monitoring system that is remotely controlled from a control room which monitors the groundwater levels and pumping rates.
Borehole WW204634		Borehole WW204634 is a monitoring borehole, drilled only into the alluvium. The borehole is located within the fenced perimeter on the western side of the brewery premises, between the logistics port and the cafeteria. Access to the borehole is currently un- restricted because it has not been

		locked and it remains open to vandalism. It has been installed with a sensor/logger to continuously measure the water level. The data on the data logger is downloaded once a month.
Borehole WW204635	 	Borehole WW204635 is a production borehole located within the fenced perimeter on the southern side of the brewery premises, on the side of the Namib Mills plant, behind the bottle storage facility. The access to the borehole is partially restricted compared to the other production boreholes. Although the borehole does not have a lockable metal container built around it, it is welded close with no means to open the metal casing without a grinder. The borehole is a standby production borehole. It is therefore not installed with an electric abstraction pump nor any sensors linked to the SCADA system.

Borehole WW 204636	 	Borehole WW204636 is a production borehole located within the fenced perimeter on the southern side of the brewery premises, on the side of the Namib Mills plant. Access to the borehole is restricted with a lockable metal container built around it An electric abstraction pump is installed for this borehole with the main switch securely locked within the container. The borehole is installed with a telemetry SCADA monitoring system that is remotely controlled from a control room which monitors the groundwater levels and pumping rates.

Borehole WW204606		Borehole WW204606 is a production borehole located within the fenced perimeter on the south-eastern side of the brewery premises, where the train enters the premises. Access to the borehole is restricted with a lockable metal container built around it. An electric abstraction pump is installed for this borehole with the main switch securely locked within the container. The borehole is installed with a telemetry SCADA monitoring system that is remotely controlled from a control room.
Borehole WW204607		Borehole WW204607 is a production borehole located within the fenced perimeter on the south-eastern side of the Cashbuild building, which is located north and outside the main brewery premises. Access to the borehole is restricted with a lockable metal container built around it An electric abstraction pump is installed for this borehole with the main switch securely locked within the container. The borehole is installed with a telemetry SCADA monitoring system that is

		remotely controlled from a control room.

APPENDIX 3: NBL AQUIFER SUSTAINABILITY ASSESSMENT

APPENDIX 4: GROUNDWATER QUALITY ANALYSIS RESULTS

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